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**Slaby et al.**

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(54) **AUXILIARY FUNCTIONALITY CONTROL  
AND FINGERPRINT AUTHENTICATION  
BASED ON A SAME USER INPUT**

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CPC ..... **G06K 9/00013** (2013.01); **G06F 3/03547**  
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(58) **Field of Classification Search**  
None  
See application file for complete search history.

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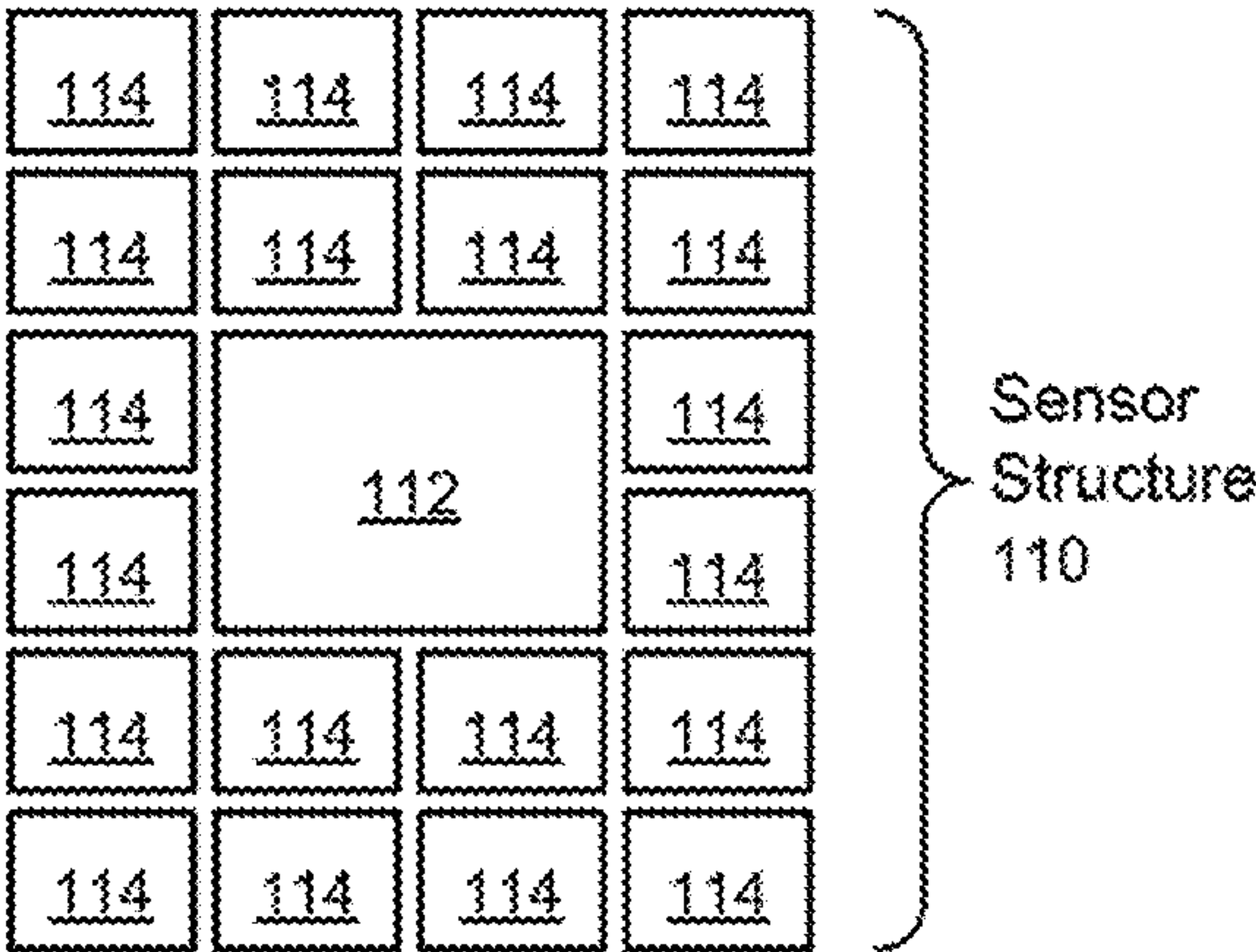
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(57) **ABSTRACT**

A sensor structure (110) for a device includes both a finger-  
print sensor (112) and one or more touch sensors (114). As a  
user input of the user moving his or her finger across the  
sensor structure is received, an appropriate auxiliary func-  
tionality operation as indicated by the pattern of movement is  
identified and performed. Additionally, during the same user  
input the fingerprint sensor senses fingerprint data identifying  
a fingerprint on the user's finger, and an attempt is made to  
authenticate the user's fingerprint. Thus, as the user provides  
a user input by moving his or her finger across the sensor  
structure, both an attempt is made to authenticate the user's  
fingerprint based on fingerprint data sensed during the user  
input and the operation requested by the user input is per-  
formed.

**23 Claims, 15 Drawing Sheets**



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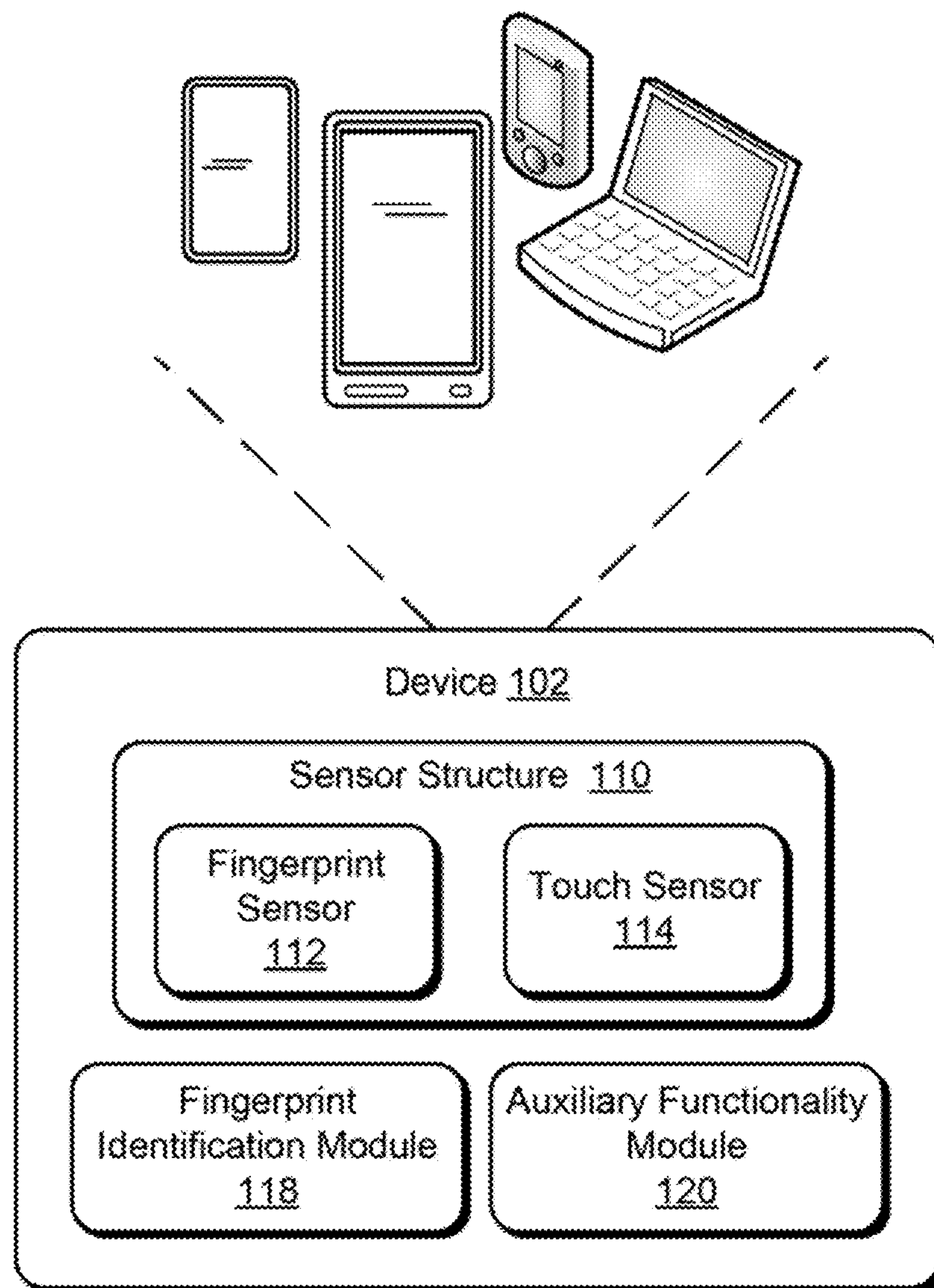
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*FIG. 1*

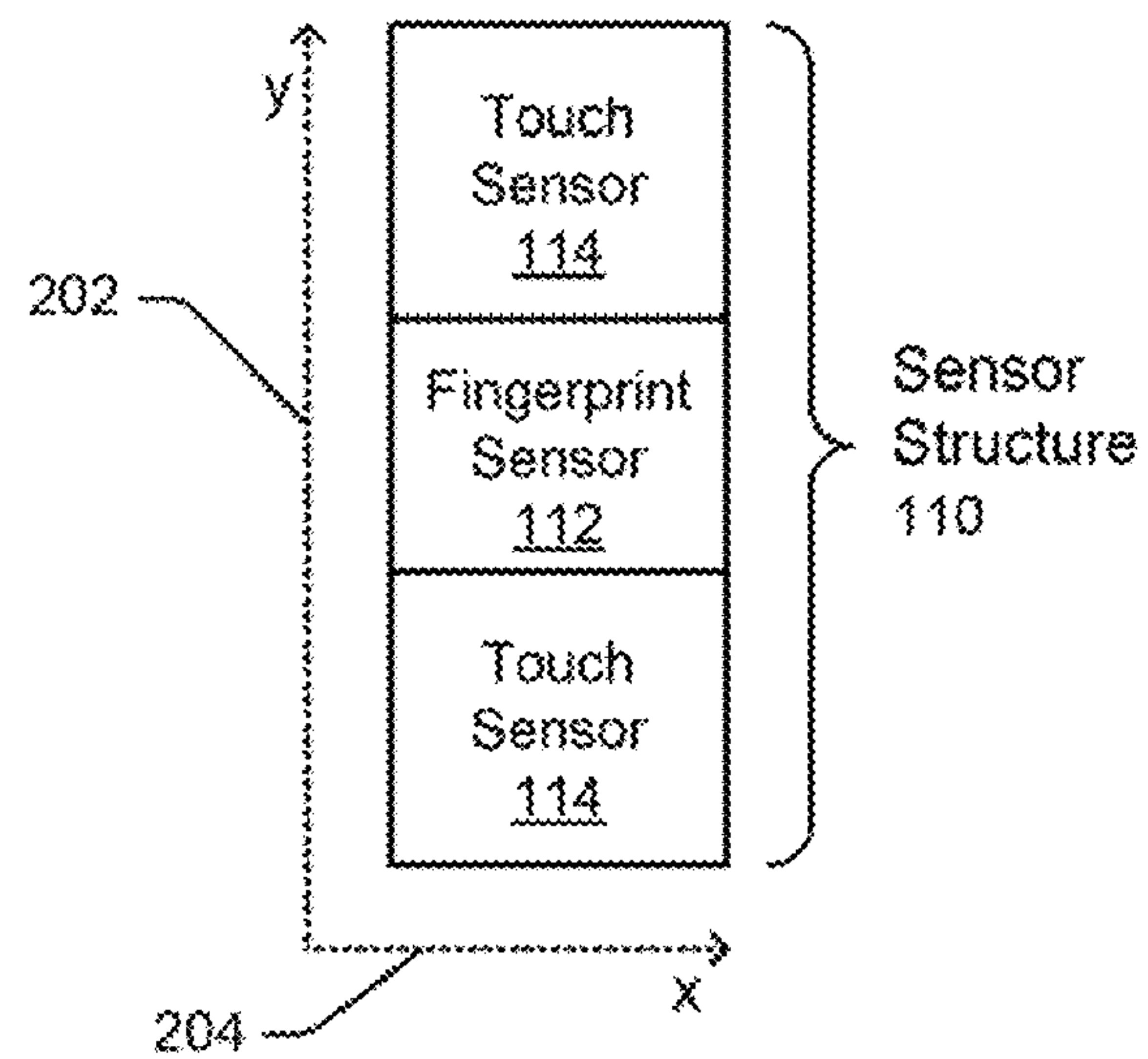


FIG. 2

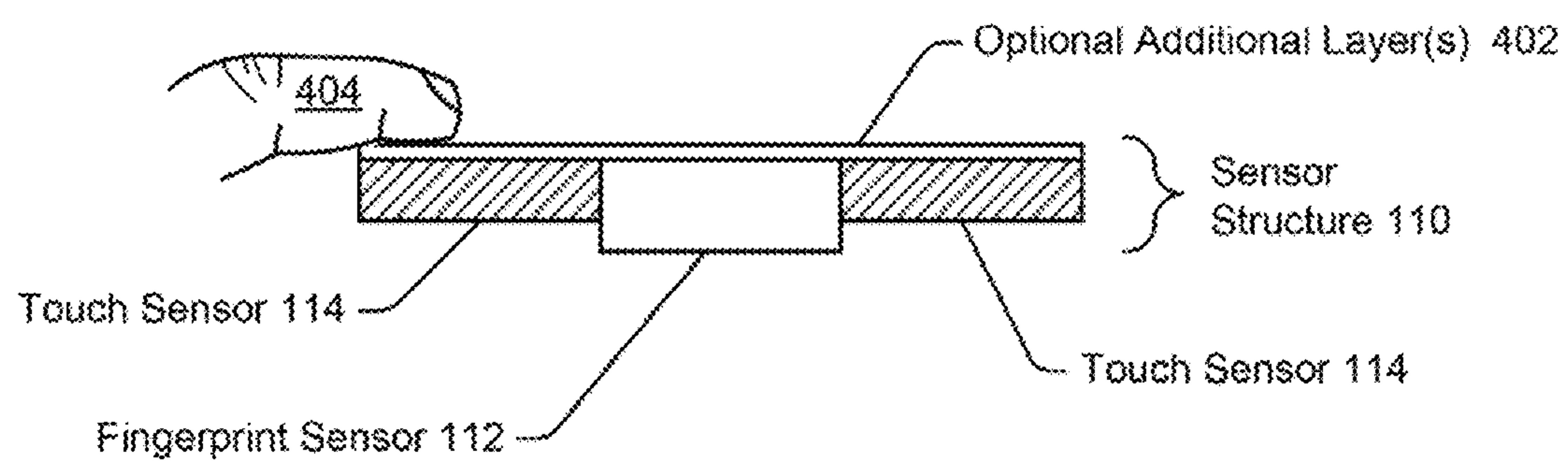


FIG. 4



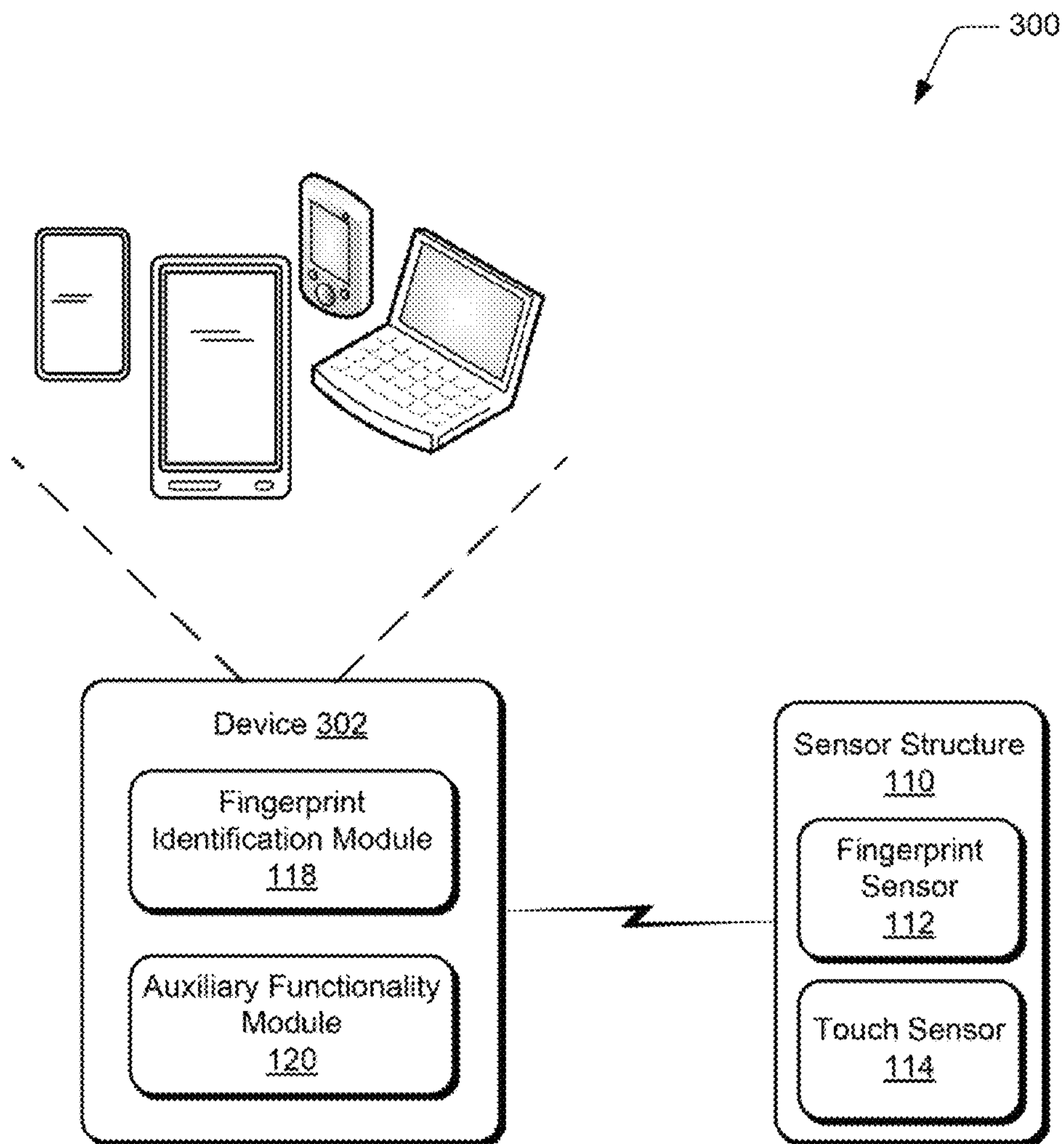
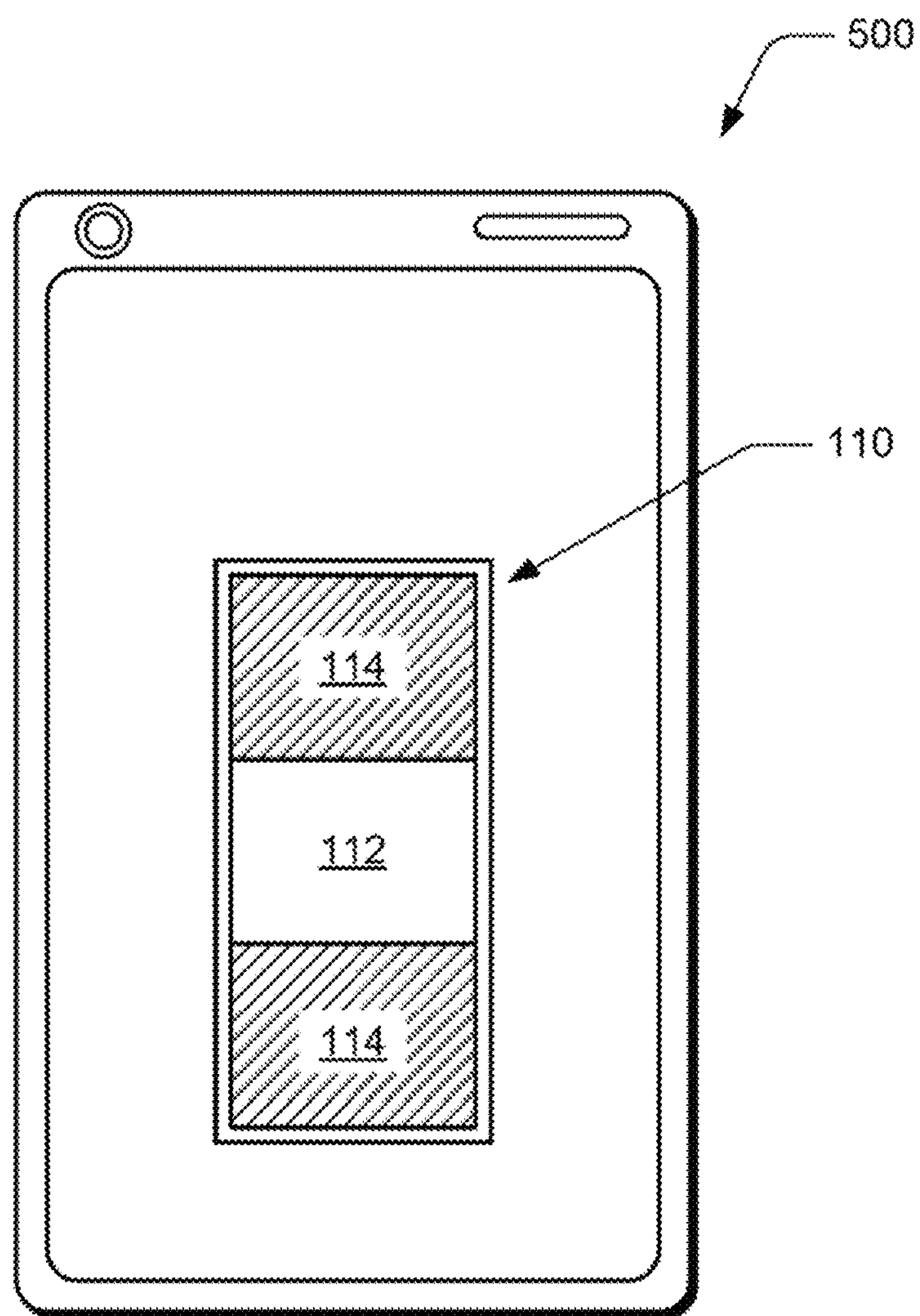
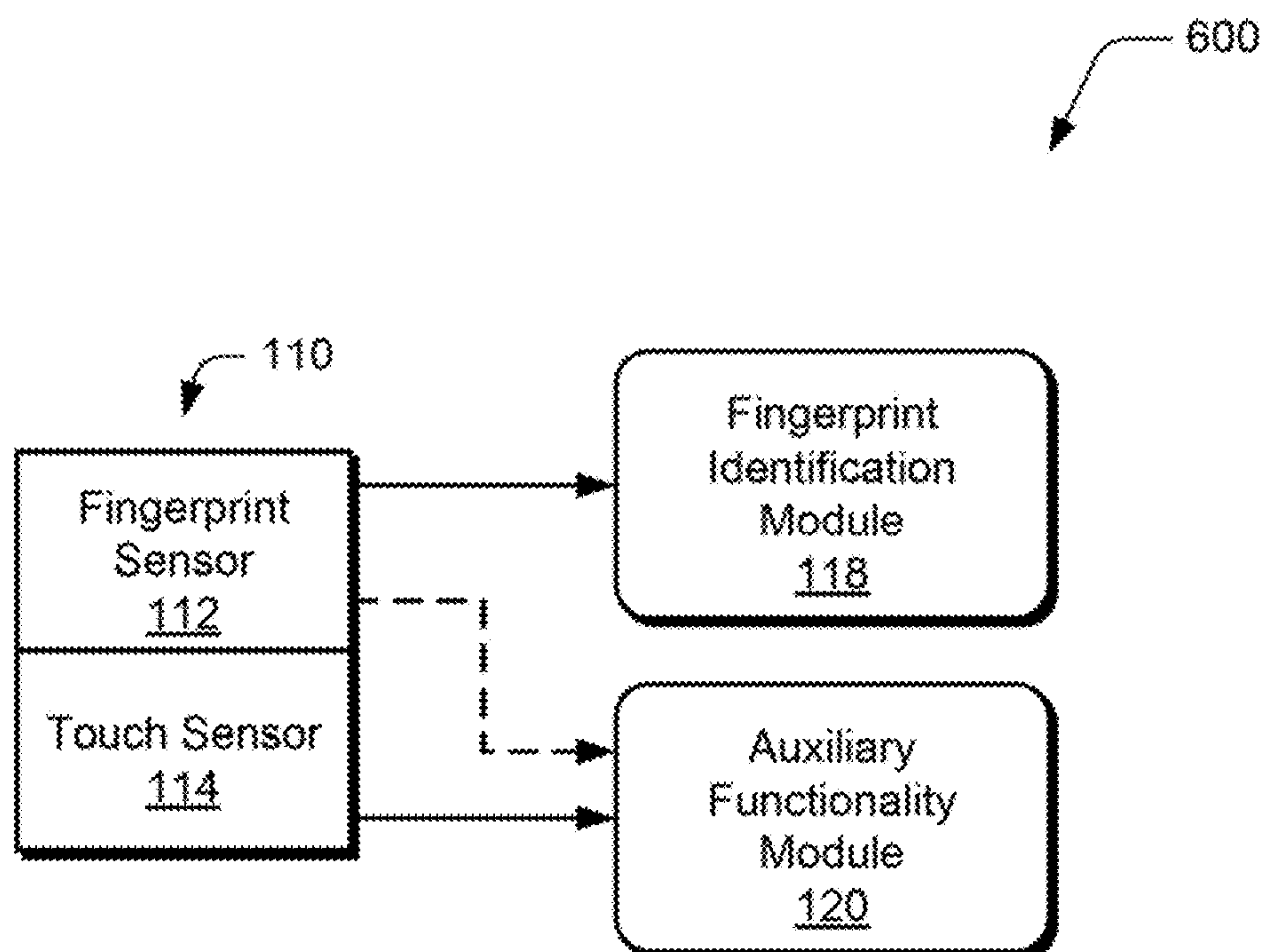
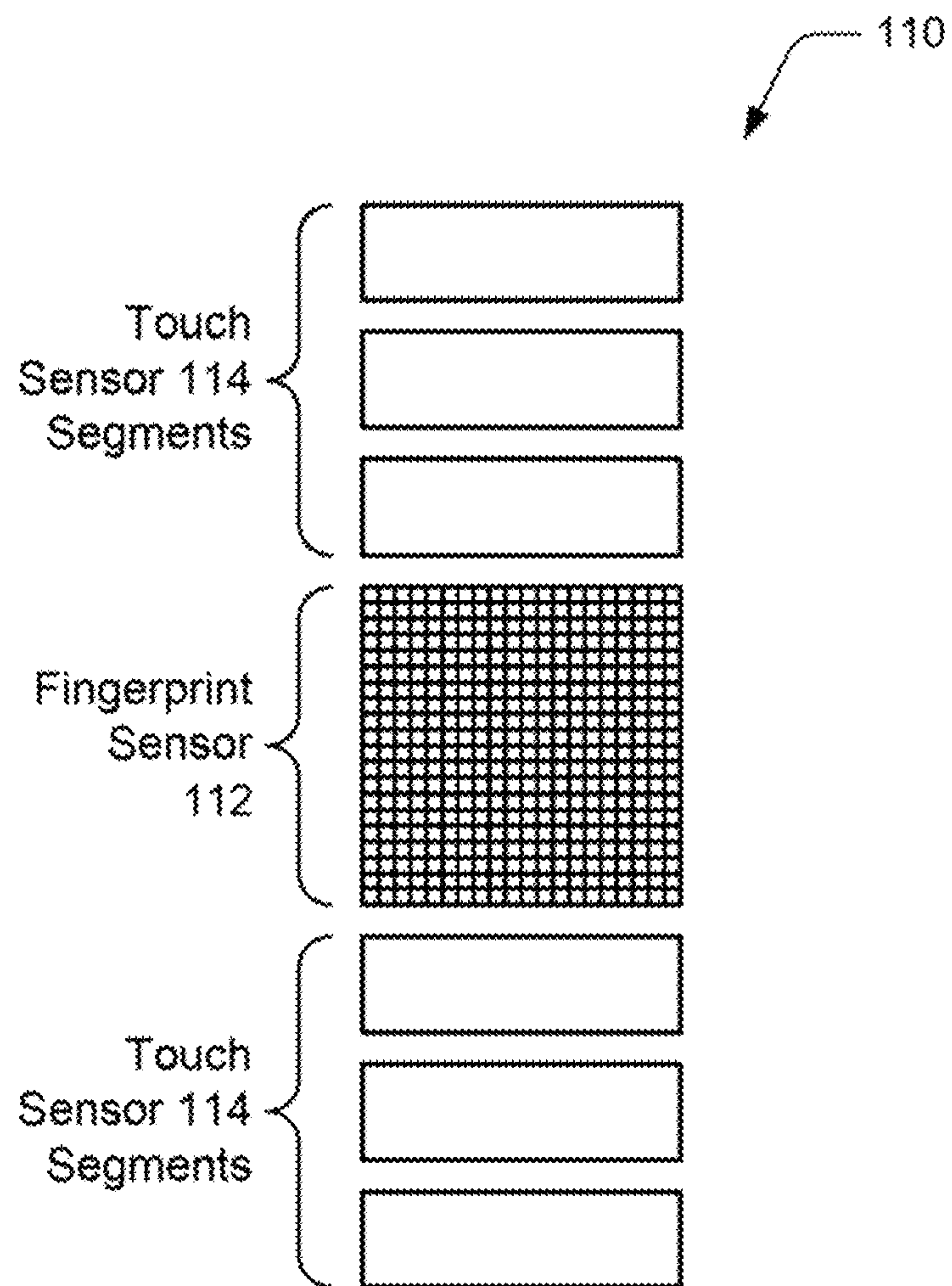


FIG. 3



*FIG. 5*

*FIG. 6*



*FIG. 7*



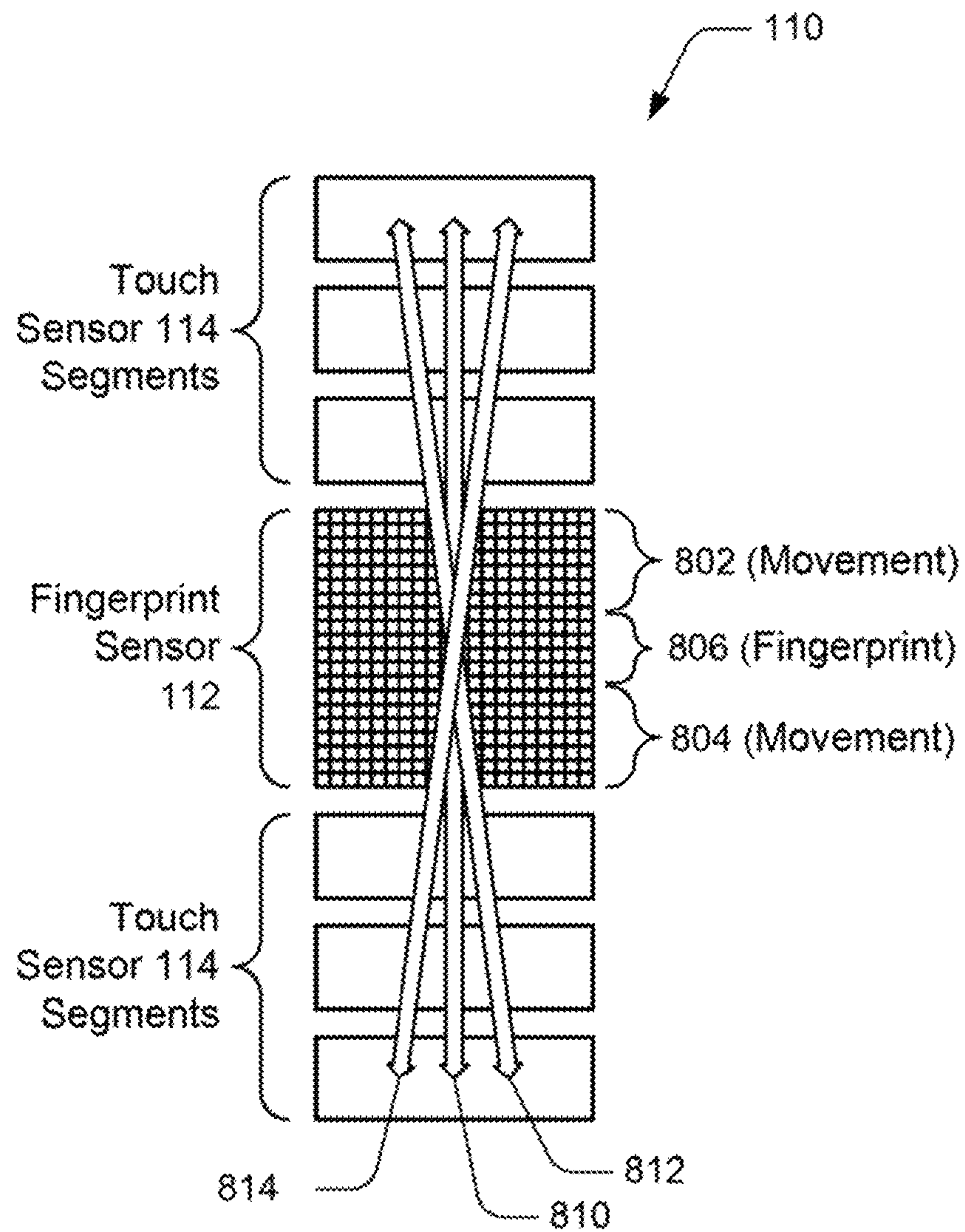


FIG. 8

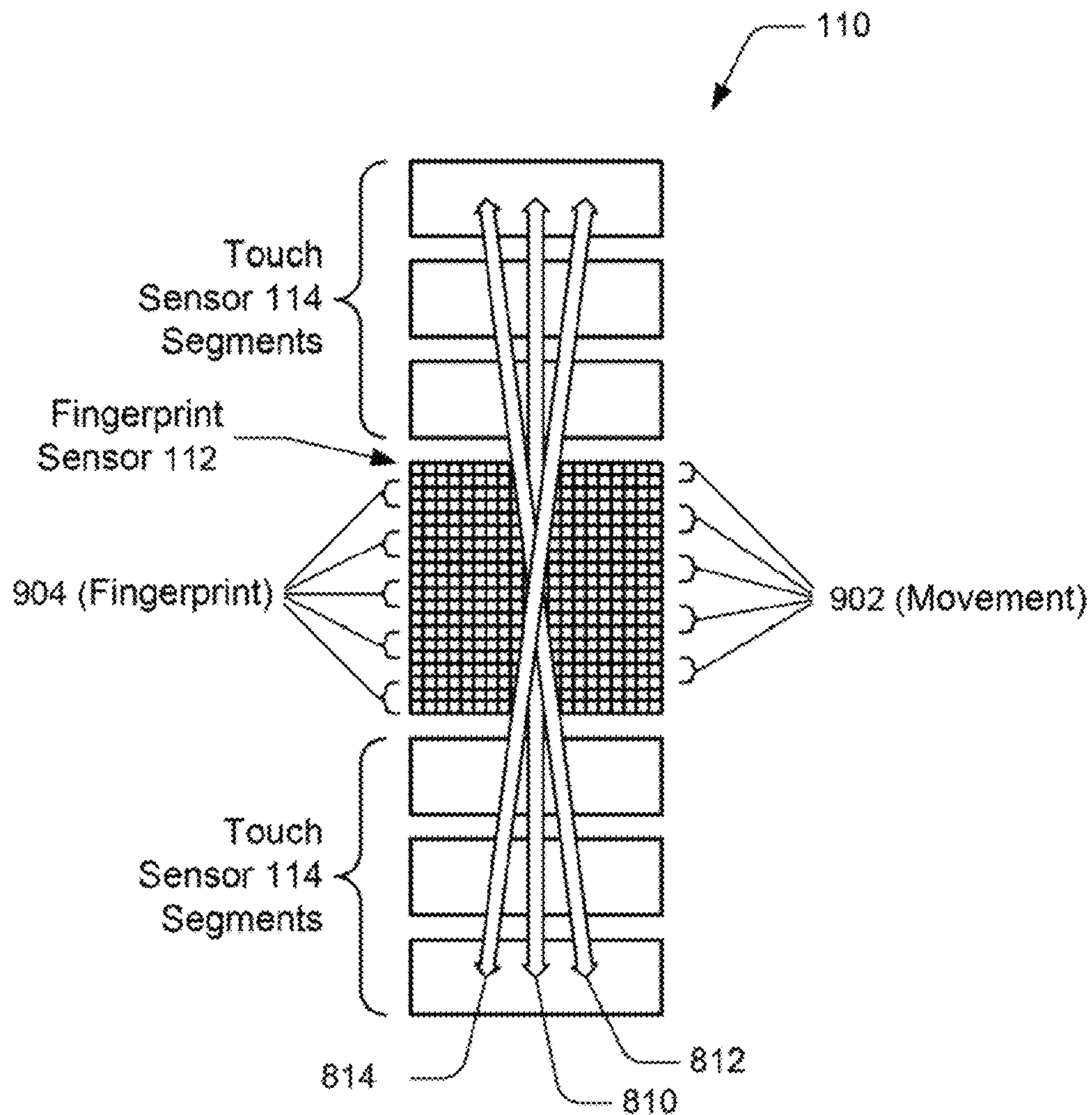
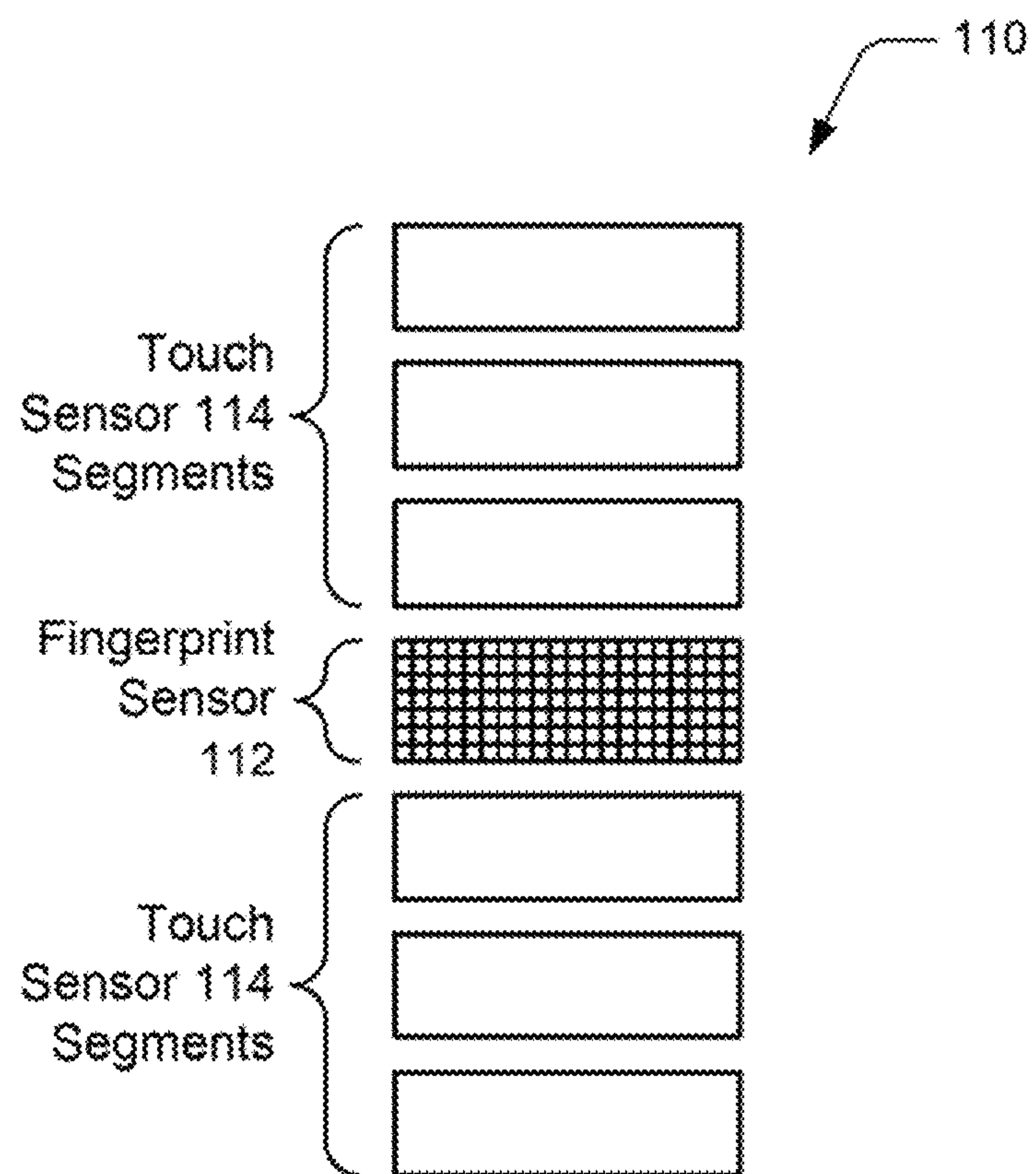
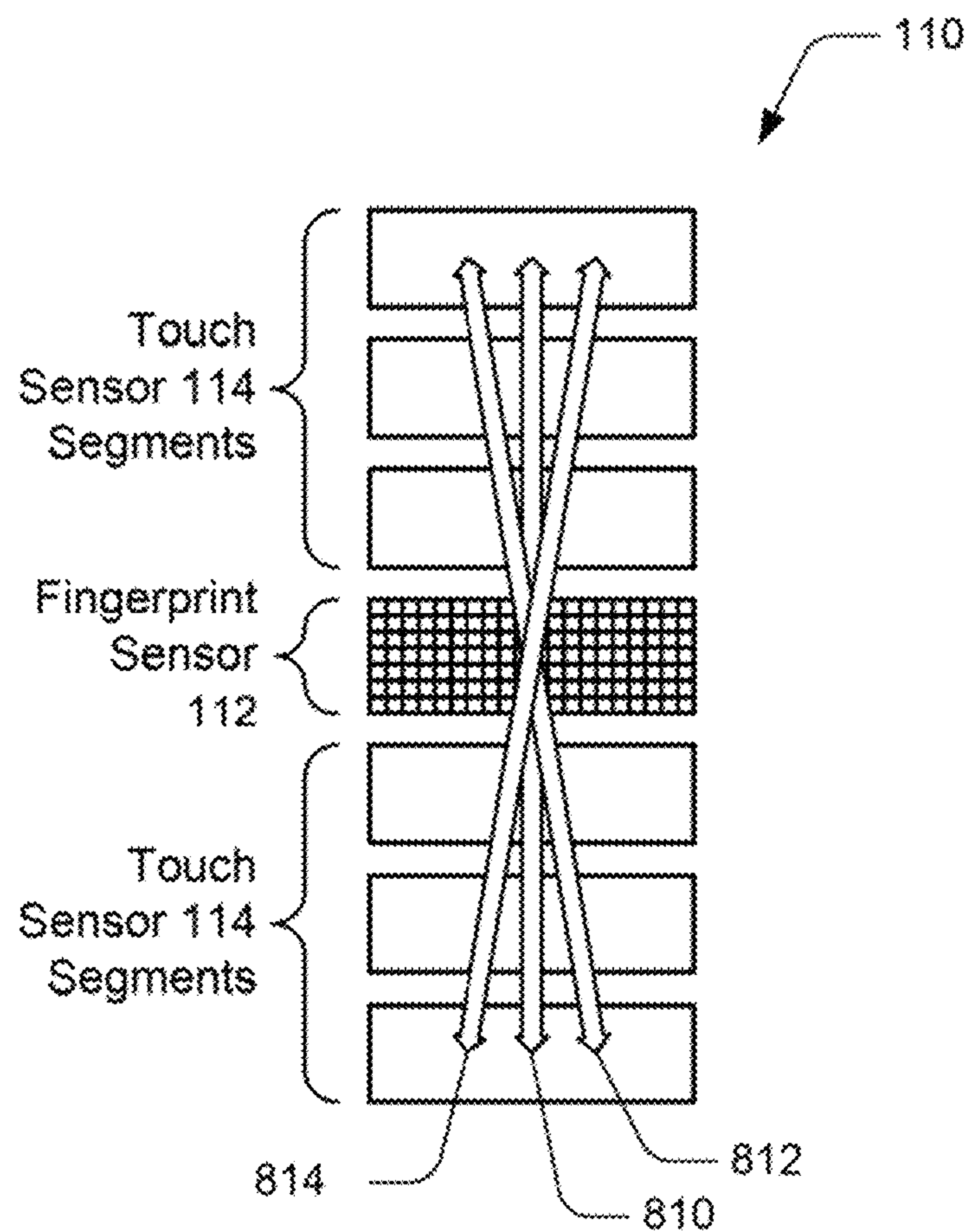


FIG. 9



**FIG. 10**



**FIG. 11**



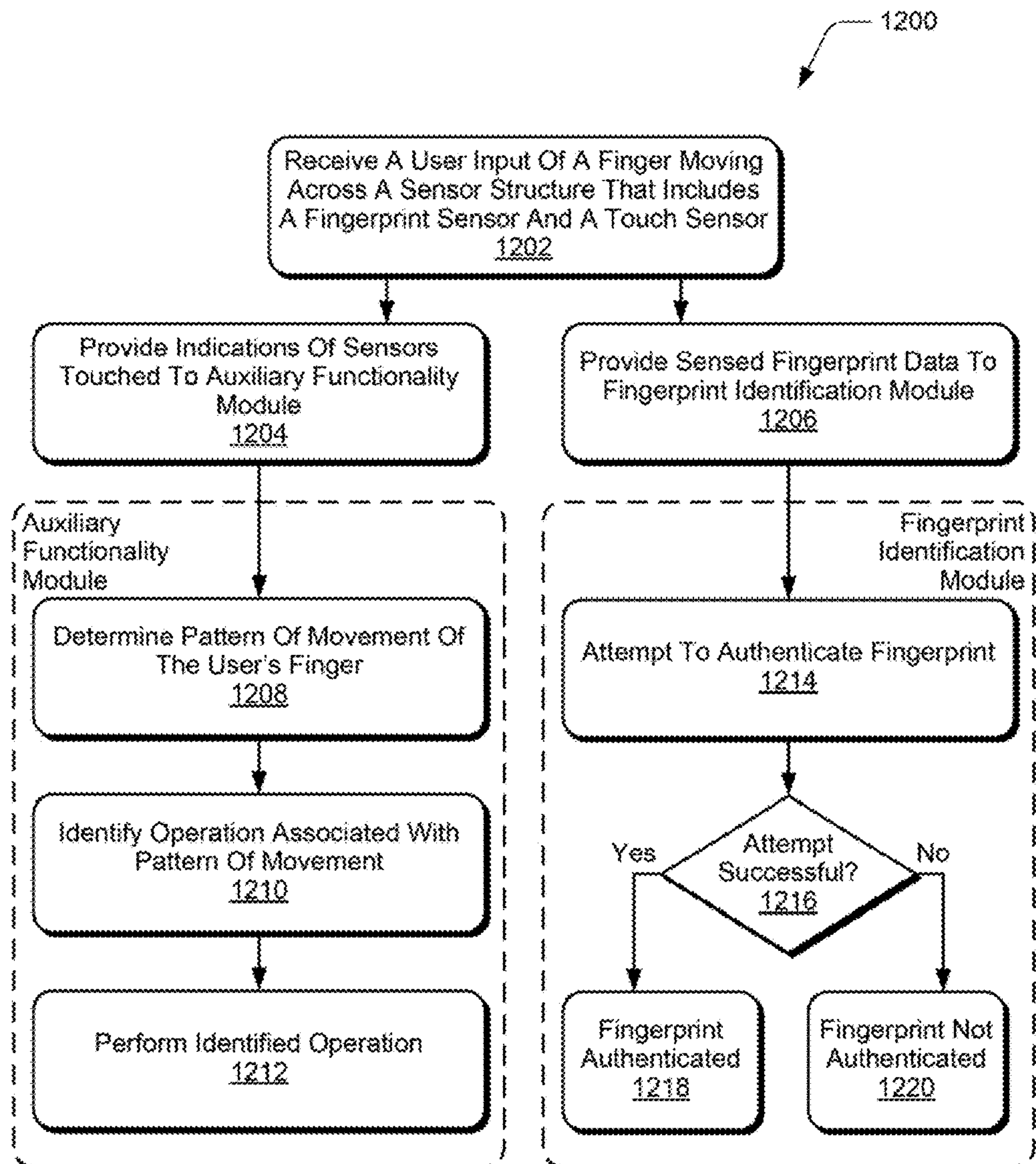


FIG. 12



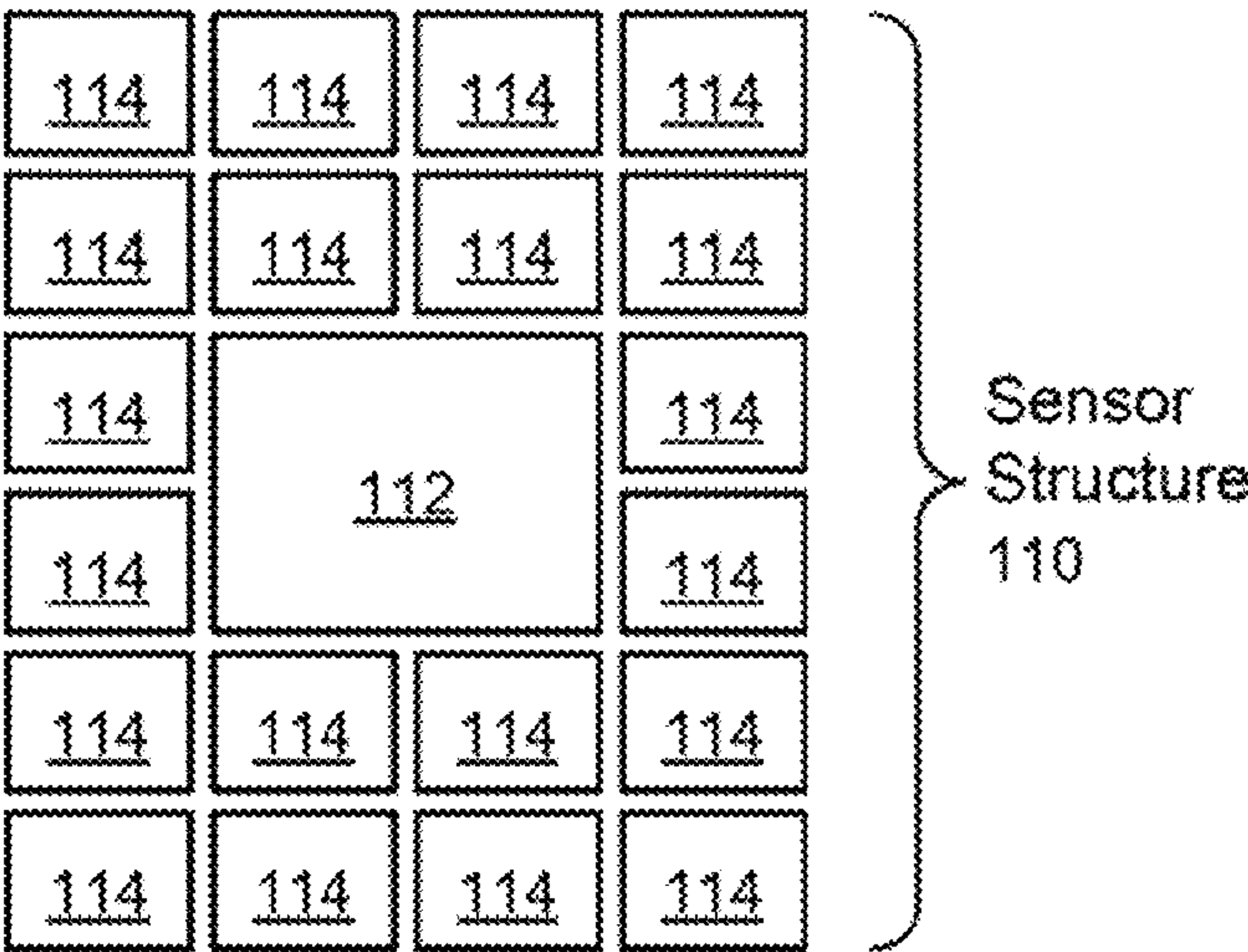


FIG. 13

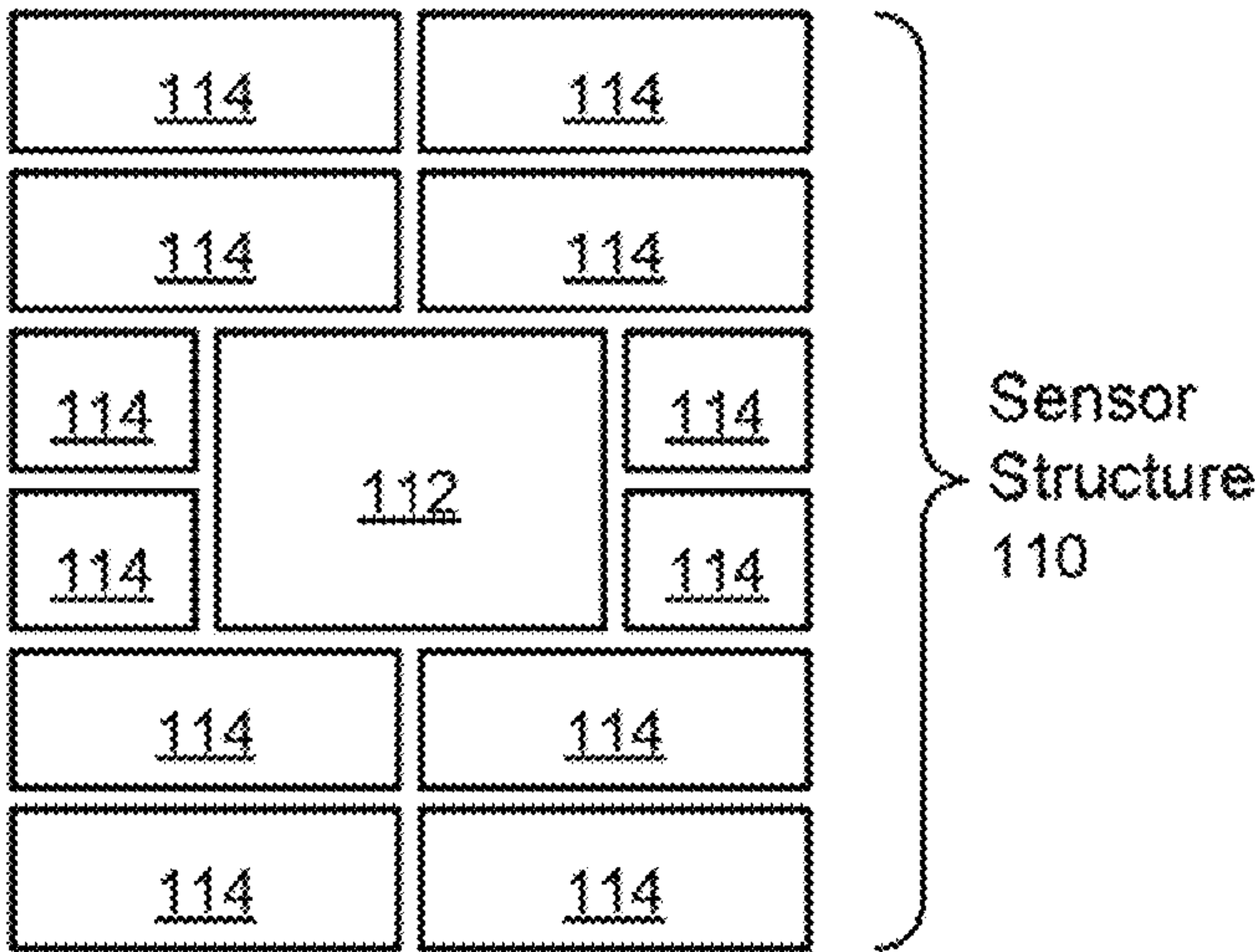


FIG. 14

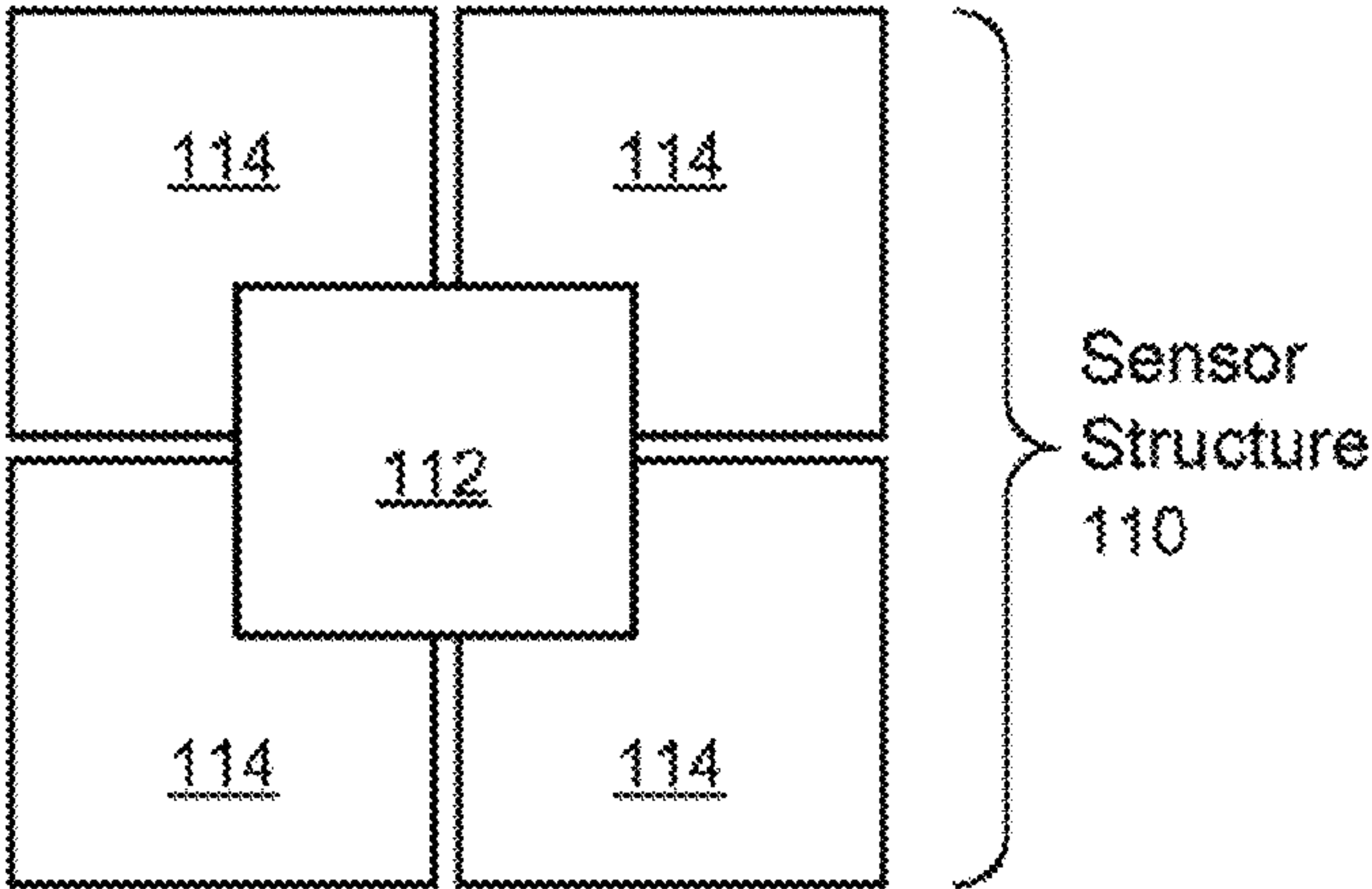


FIG. 15

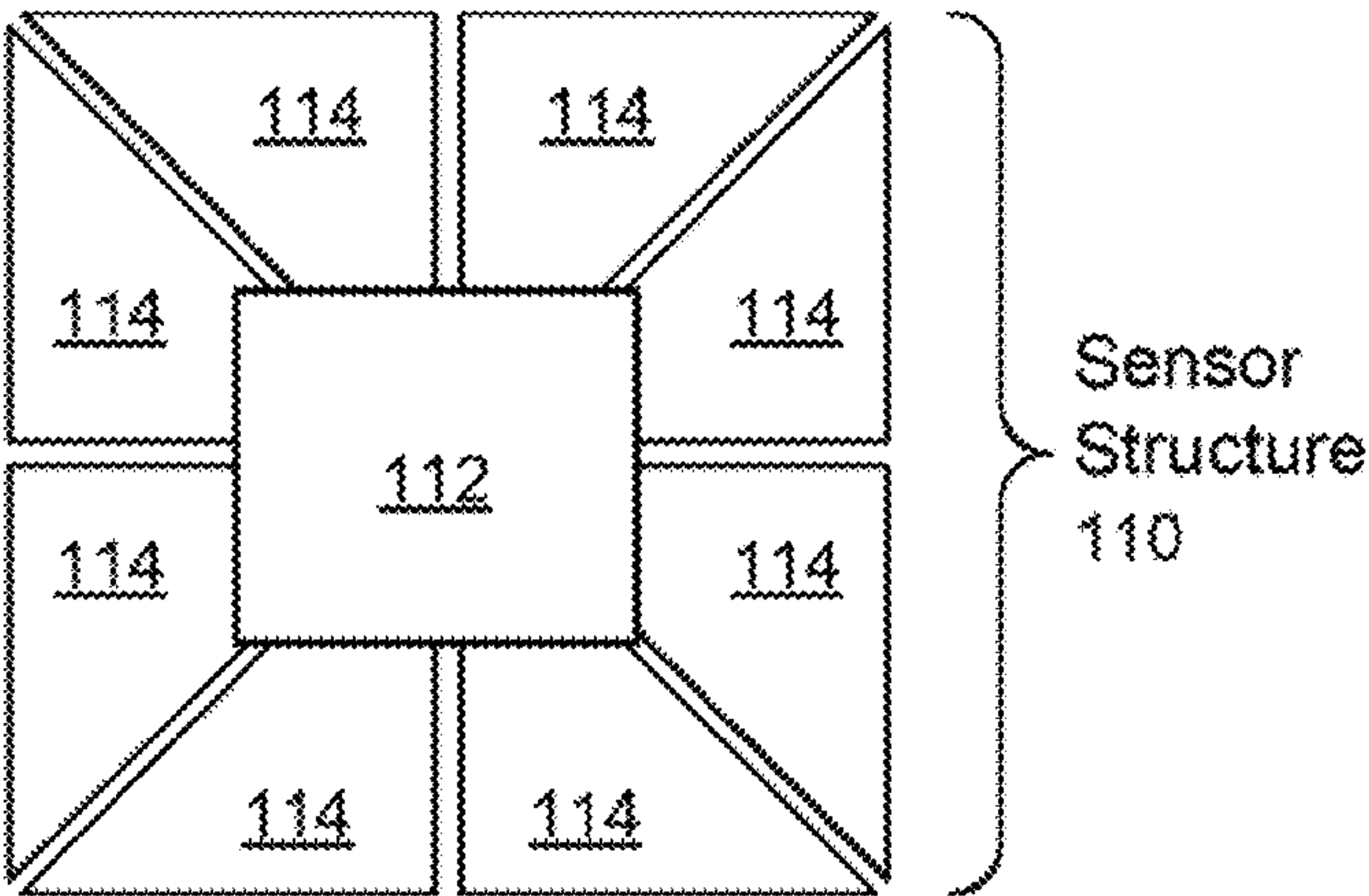
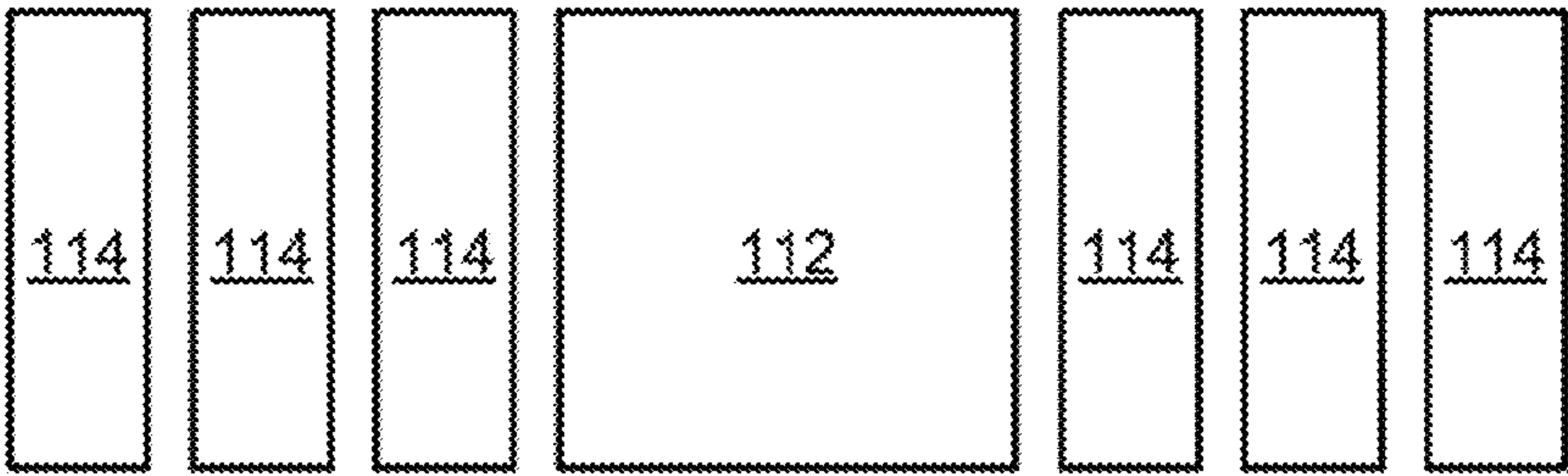
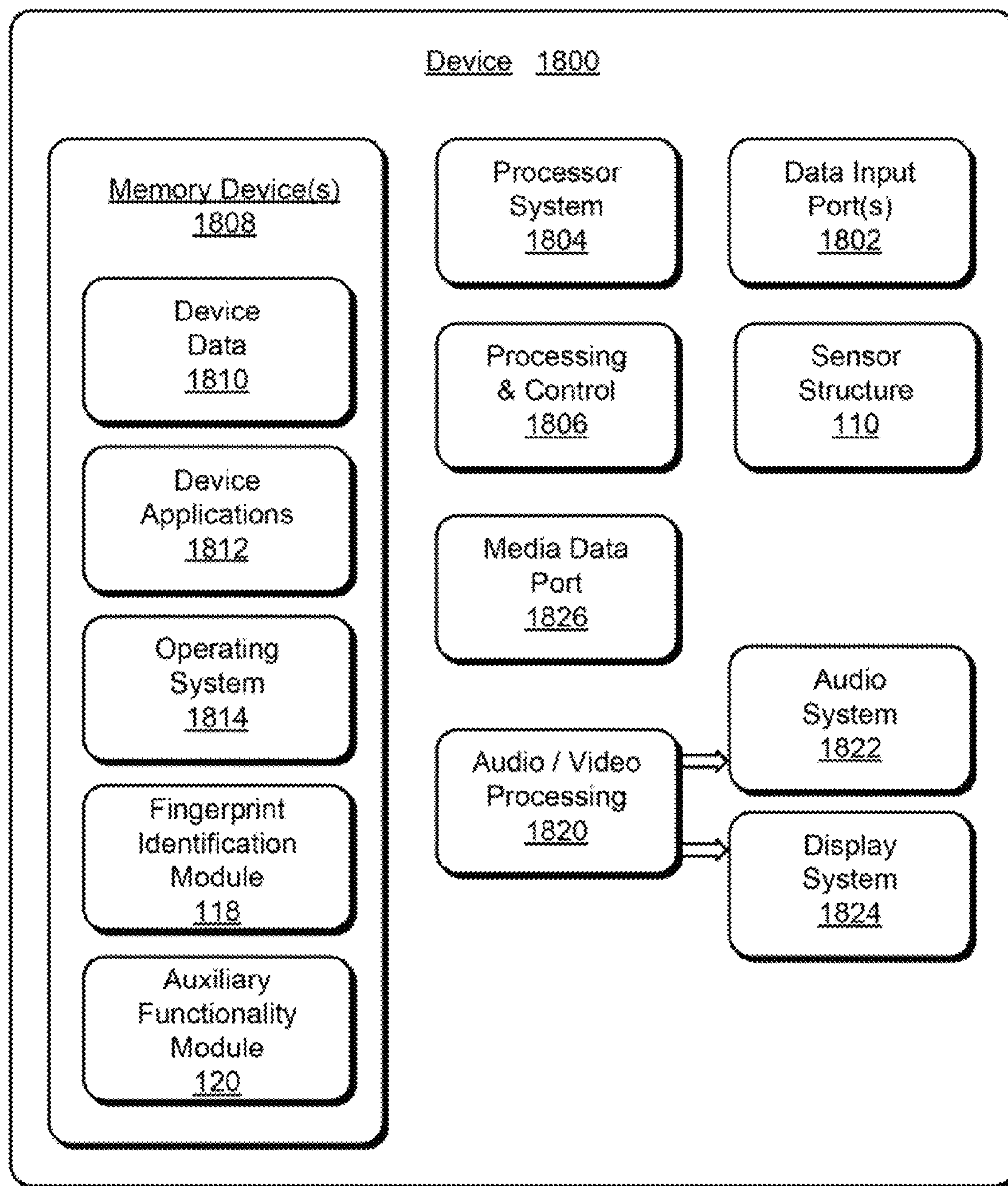


FIG. 16



*FIG. 17*

*FIG. 18*



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# AUXILIARY FUNCTIONALITY CONTROL AND FINGERPRINT AUTHENTICATION BASED ON A SAME USER INPUT

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to co-owned U.S. patent application Ser. No. 13/832,032, entitled AUXILIARY DEVICE FUNCTIONALITY AUGMENTED WITH FINGERPRINT SENSOR and filed concurrently herewith.

## BACKGROUND

One way in which access to systems or devices can be controlled is through the use of fingerprint authentication, in which a user's fingerprint is captured by a fingerprint sensor and authenticated. However, current authentication systems are not without their problems. One such problem is that authentication systems sometimes assume that a user of the phone does not change for an amount of time after the user is authenticated. This can result in situations where the user of the phone changes, but this change is not discovered by the authentication system.

## BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of auxiliary functionality control and fingerprint authentication based on a same user input are described with reference to the following drawings. The same numbers are used throughout the drawings to reference like features and components:

FIG. 1 illustrates an example device implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments;

FIG. 2 illustrates a top-down view of an example sensor structure in accordance with one or more embodiments;

FIG. 3 illustrates an example system implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments;

FIG. 4 illustrates a cross-section view of an example sensor structure in accordance with one or more embodiments;

FIG. 5 illustrates an example device that includes a sensor structure in accordance with one or more embodiments;

FIG. 6 illustrates an example system implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments;

FIGS. 7, 8, and 9 illustrate top-down views of an example sensor structure including touch fingerprint sensors in accordance with one or more embodiments;

FIGS. 10 and 11 illustrate top-down views of an example sensor structure including swipe fingerprint sensors in accordance with one or more embodiments;

FIG. 12 illustrates an example process implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments;

FIGS. 13, 14, 15, 16, and 17 each illustrate a different example sensor structure that includes the fingerprint sensor surrounded by touch sensors in accordance with one or more embodiments; and

FIG. 18 illustrates various components of an example electronic device that can implement embodiments of the auxil-

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ary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments.

## DETAILED DESCRIPTION

Auxiliary functionality control and fingerprint authentication based on a same user input is discussed herein. A sensor structure for a device includes both a fingerprint sensor and one or more touch sensors. The sensor structure serves as an input mechanism to allow a user to provide input to control auxiliary functionality of the device by moving his or her finger across the sensor structure, and also to allow the user's fingerprint to be authenticated while moving his or her finger across the sensor structure. Various auxiliary functionality of the device can be controlled, such as the volume of audio output by the device, phone call control functionality (e.g., answering or hanging up phones), scrolling or panning through data displayed on the device, zooming in or out of a display of the device, and so forth.

As a user input of the user moving his or her finger across the sensor structure is received, an appropriate auxiliary functionality operation as indicated by the pattern of movement is identified and performed. Additionally, during the same user input the fingerprint sensor senses fingerprint data identifying a fingerprint on the user's finger, and an attempt is made to authenticate the user's fingerprint. Thus, as the user provides a user input by moving his or her finger across the sensor structure, both an attempt is made to authenticate the user's fingerprint based on fingerprint data sensed during the user input and the operation requested by the user input is performed.

FIG. 1 illustrates an example device **102** implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments. The device **102** can be any of a variety of different types of devices, such as a laptop computer, a cellular or other wireless phone, a tablet computer, an entertainment device, a wearable device, an audio and/or video playback device, a server computer, and so forth. The device **102** includes a sensor structure **110** having a fingerprint sensor **112**, a touch sensor **114**, a fingerprint identification module **118**, and an auxiliary functionality module **120**.

The fingerprint sensor **112** can sense fingerprint data of a user's finger touching the sensor **112**. The fingerprint data identifies a fingerprint's pattern on the finger, typically identifying the location of various ridges and/or minutiae of the fingerprint. The fingerprint sensor **112** can be implemented using any of a variety of different technologies and types of sensors, such as capacitive sensors, pressure sensors, resistive sensors, optical sensors, thermal sensors, acoustic sensors, ultrasonic sensors, imaging sensors, and so forth. The fingerprint sensor **112** can be implemented as a touch fingerprint sensor or as a swipe fingerprint sensor as discussed in more detail below.

The touch sensor **114** senses a user's finger touching the sensor **114**, and the fingerprint sensor **112** senses a user's finger touching the sensor **112**. However, the touch sensor **114** differs from the fingerprint sensor **112** in that the touch sensor **114** does not sense fingerprint data of a user's finger touching the sensor **114**. The touch sensor **114** can be implemented using any of a variety of different technologies and types of sensors, such as capacitive sensors, pressure sensors, optical sensors, thermal sensors, acoustic sensors, ultrasonic sensors, imaging sensors, and so forth. The touch sensor **114** can be implemented using the same technology and type of



sensor as the fingerprint sensor **112**, or alternatively using a different technology or type of sensor as the fingerprint sensor **112**.

It should be noted that, although the fingerprint sensor **112** and the touch sensor **114** are illustrated in FIG. **1**, the device **102** can include any number of fingerprint sensors **112** and any number of touch sensors **114**.

It should also be noted that although many of the discussions herein refer to the touch sensor **114** and the fingerprint sensor **112** as sensing a finger, the touch sensors **114** and the fingerprint sensor **112** can optionally sense various other objects. For example, the sensors **112** and **114** may sense a stylus, a pen, a brush, or other object touching the sensors **112** and **114**. However, the fingerprint sensor **112** can only sense a fingerprint on an object that has a fingerprint (e.g., a finger). References are made herein to a finger touching the sensors **112** or **114** or moving across the sensors **112** or **114** as examples, and it should be noted that such references also refer to other objects touching or moving across the sensors **112** or **114**.

The fingerprint sensor **112** and one or more touch sensors **114** are situated adjacent to one another, and together form the sensor structure **110**. One sensor being adjacent to another sensor refers to the two sensors being in physical contact with one another or within a threshold distance (e.g., a few millimeters) of one another. The sensors may be separate components, or may be built in the same component or substrate, such as a rigid printed circuit board (PCB) or flex PCB, or indium tin oxide (ITO) on glass or plastic. FIG. **2** illustrates a top-down view of an example sensor structure **110** in accordance with one or more embodiments. The sensor structure **110** includes the fingerprint sensor **112** adjacent to two touch sensors **114**. In the illustrated example of FIG. **2**, the fingerprint sensor **112** is situated between the two touch sensors **114**, with one touch sensor **114** being situated above the fingerprint sensor **112** and one touch sensor **114** being situated below the fingerprint sensor **112**. Various examples of sensor structures **110** are discussed herein, illustrated with rectangular sensors **112** and **114**. It should be noted that these are examples, and that a fingerprint sensor **112** can have any shape (e.g., circular, rectangular, triangular, and so forth) and that a touch sensor **114** can have any shape (e.g., circular, rectangular, triangular, and so forth). A touch sensor **114** can have the same shape as the fingerprint sensor **112**, or alternatively a different shape.

Returning to FIG. **1**, the fingerprint identification module **118**, and optionally the auxiliary functionality module **120** as well, receives inputs from the fingerprint sensor **112** indicating a finger touching the fingerprint sensor **112**. Additionally, the auxiliary functionality module **120** receives inputs from the touch sensor **114** indicating a finger touching the touch sensor **114**. The inputs are used by the fingerprint identification module **118** to attempt to authenticate the user's fingerprint, and used by the auxiliary functionality module **120** to identify and perform a particular operation.

The fingerprint identification module **118** analyzes fingerprint data for a fingerprint sensed by the fingerprint sensor **112** in order to authenticate the fingerprint. To authenticate the fingerprint, the fingerprint data is compared to a fingerprint template. The fingerprint template refers to fingerprint data that has been previously sensed or otherwise obtained (e.g., during an initial enrollment process) and that can be used as valid fingerprint data for the user. The fingerprint template can be stored at the device **102** or at another device accessible to the device **102**, and the module **118** uses the fingerprint template to authenticate the fingerprint. It should be noted that fingerprint authentication can be performed by

the device **102** for its own use and/or use by another system or device. For example, the fingerprint identification module **118** can authenticate fingerprints in order to allow a user to access the device **102** itself, to allow a user to access programs or applications running on the device **102**, to allow a user to access other modules or components of the device **102**, to personalize the device **102**, to direct access modes of the device **102**, and so forth. Alternatively, the fingerprint identification module **118** can authenticate fingerprints in order to allow a user to access another system or device coupled to the device **102**, to allow a user to access another system or device accessed by the device **102** via the Internet or other network, and so forth.

The auxiliary functionality module **120** provides auxiliary functionality to the device **102**. This auxiliary functionality can take a variety of different forms, and can be any functionality that can be controlled at least in part based on movement of a finger across the sensor structure. In one embodiment, the auxiliary functionality is volume control, and the module **120** increases or decreases the volume level of one or more sounds output by the device **102** in response to movement of a finger across the sensor structure **110**. In another embodiment, the auxiliary functionality is call control, and the module **120** answers or ends a phone call (or other communication channel) of for the device **102** in response to movement of a finger across the sensor structure **110**. In another embodiment, the auxiliary functionality is cursor control, and the module **120** moves a cursor or other user interface object or component displayed to a user of the device **102** in response to movement of a finger across the sensor structure **110**. In other embodiments, the auxiliary functionality module **120** can provide various other functionality based at least in part on movement of a finger across the sensor structure **110**, such as capturing photos or videos, capturing audio recordings, scrolling through lists or displays, panning through information displayed on a display of the device **102**, zooming in or out of a display of the device **102**, menu item switching, and so forth.

FIG. **3** illustrates an example system **300** implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments. The system **300** includes a device **302** that can be any of a variety of different types, analogous to the discussion of device **102** of FIG. **1**. The device **302** is similar to the device **102** of FIG. **1**, and includes a fingerprint identification module **118** and an auxiliary functionality module **120**. However, the device **302** differs from the device **102** in that the device **302** does not include the sensor structure **110**.

Sensor structure **110** includes a fingerprint sensor **112** and a touch sensor **114**. In system **300**, the sensor structure **110** is implemented separately from the device **302**, and provides data (e.g., indications of a finger touching the fingerprint sensor **112** or the touch sensor **114**) to the device **302**. This data can be provided via a variety of different communication channels, including wired communication channels, such as Universal Serial Bus (USB) connections, and/or wireless communication channels. Various different wireless communication channels can be used, such as wireless USB channels, Bluetooth channels, WiFi channels, Bluetooth Low Energy (BTLE) channels, near field communication (NFC) channels, TransferJet channels, radio frequency (RF) channels, optical channels, infrared (IR) channels, and so forth. In one or more embodiments, the sensor structure **110** is implemented as a wearable device, such as part of a watch or other jewelry that communicates with the device **302** implemented as another wearable device.

In the illustrated example of FIG. **3**, the fingerprint identification module **118** and the auxiliary functionality module



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120 are both included as part of the device 302. Alternatively, at least part of the fingerprint identification module 118 can be included in the sensor structure 110. Similarly, at least part of the auxiliary functionality module 120 can optionally be included in the sensor structure 110.

FIG. 4 illustrates a cross-section view of an example sensor structure 110 in accordance with one or more embodiments. The sensor structure 110 includes the fingerprint sensor 112 adjacent to two touch sensors 114, with the touch sensors 114 being illustrated with cross-hatching. In the illustrated example of FIG. 4, the fingerprint sensor 112 is situated between the two touch sensors 114. The fingerprint sensor 112 and each touch sensor 114 can be a physically separate sensor, or alternatively can be separate areas built onto a single substrate or component (e.g., be on the same plane of the same material). The sensor structure 110 also optionally includes one or more additional layers 402 situated on top of the sensor structure 110. The one or more layers 402 can supplement the sensors 112 and 114 in various manners, such as by providing protection from scratches and abrasions, by providing protection from water or other elements, and so forth. It should be noted that the one or more layers 402 are optional and need not be included in sensor structure 110. It should also be noted that, although illustrated as being at the top of the sensor structure 110 or above the fingerprint sensor 112 and the touch sensor 114, one or more additional layers can optionally be included below the fingerprint sensor and the touch sensor 114.

A finger 404 touching the sensor structure 110 is also illustrated in FIG. 4. Depending on the location where the finger touches the sensor structure, one of the touch sensors and/or the fingerprint sensor 112 can sense the finger 404 touching the sensor structure 110. In some situations, the fingerprint sensor 112 also senses fingerprint data of the finger 404. It should be noted that in situations in which the sensor structure 110 includes one or more additional layers 402, the touch sensor 114 senses a finger touching the additional layer of the sensor structure 110 above the touch sensor 114 even though the finger is not in physical contact with the touch sensor 114, and the fingerprint sensor 112 senses a finger touching the additional layer of the sensor structure 110 above the fingerprint sensor 112 even though the finger is not in physical contact with the fingerprint sensor 112.

The fingerprint sensor 112 is illustrated as having a different height or depth than the touch sensors 114. The fingerprint sensor 112 can be implemented using different technologies than the touch sensors 114, and thus may be a different size. Despite the different sizes, a top surface (the surface closest to finger 404) of the fingerprint sensor 112 is approximately flush with the top surface (the surface closest to finger 404) of the touch sensors 114, and thus the fingerprint sensor 112 and the touch sensors 114 are also referred to as being in the same plane. By having the top surfaces of sensors 112 and 114 flush with one another, the user is typically not able to feel any separation or difference between sensors 112 and 114 when moving his or her finger across the top surface of the sensor structure 110.

The sensor structure 110 in FIG. 4 is illustrated as having a top surface of the fingerprint sensor 112 being approximately flush with the top surface of the touch sensors 114. Alternatively, rather than the top surface of the fingerprint sensor 112 being approximately flush with the top surface of the touch sensors 114, the top surface of the fingerprint sensor 112 (and the area of any additional layers 402 above the fingerprint sensor 112) may be slightly recessed or slightly raised relative to the top surface of the touch sensors 114. Various amounts of recession or raising can be used, and allow the user to be

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able to feel a separation or difference between sensors 112 and 114 when moving his or her finger across the top surface of the sensor structure 110. Alternatively, the area of the sensor structure 110 that includes the fingerprint sensor 112 can be identified to a user in other manners, such as an additional layer 402 may have a different color or texture for areas above the fingerprint sensor 112 than for areas above the touch sensors 114, an additional layer 402 may include a slight protrusion (e.g., a bump) outward from the top surface of the sensor structure 110 in an area above the fingerprint sensor 112 (e.g., centered above the fingerprint sensor 112), and so forth.

FIG. 5 illustrates an example device 500 that includes the sensor structure 110 in accordance with one or more embodiments. The device 500 is, for example, a mobile device such as a wireless phone. The sensor structure 110 is implemented on one side of the device 500, such as on the back of the phone. The sensor structure 110 includes a fingerprint sensor situated between two touch sensors (the touch sensors being illustrated with cross-hatching), with one touch sensor being situated above the fingerprint sensor and one touch sensor being situated below the fingerprint sensor analogous to the sensor structure 110 of FIG. 2.

FIG. 6 illustrates an example system 600 implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments. The system 600 can be implemented by a single device (e.g., the device 102 of FIG. 1) or multiple devices (e.g., the device 302 and a device implementing the sensor structure 110 of FIG. 3). The system 600 includes the sensor structure 110 including one or more touch sensors 114 and one or more fingerprint sensors 112.

When a finger is touching the touch sensor 114, the sensor 114 provides an indication to the auxiliary functionality module 120 of the sensor 114 being touched by the finger. This indication can take various forms. In one embodiment, the touch sensor 114 is implemented as a single sensor (also referred to as a discrete sensor), which refers to the sensor 114 being able to detect either that the sensor is being touched or not being touched. In this embodiment, the sensor 114 provides to the auxiliary functionality module 120 an indication that either the sensor is being touched or not being touched. In another embodiment, the touch sensor 114 is implemented in a grid-type arrangement that can provide at least some indication of where the sensor is being touched (as opposed to simply that the sensor is being touched or not being touched). In this embodiment, the sensor 114 provides to the auxiliary functionality module 120 an indication of where the sensor is being touched, such as one or more coordinates (e.g., using a Cartesian coordinate system) on the sensor 114 that are touched, and so forth.

The fingerprint sensor 112 is implemented in a grid-type arrangement that is capable of reproducing a fingerprint image or characteristics. In one embodiment, when a finger is touching the fingerprint sensor 112, the sensor 112 senses fingerprint data of the finger and provides an indication of the fingerprint data to the fingerprint identification module 118.

In another embodiment, the fingerprint sensor 112 includes multiple sections. When a finger is touching one or more particular sections of the fingerprint sensor 112, the sensor 112 senses fingerprint data of the finger at those sections and provides an indication of the fingerprint data to the fingerprint identification module 118. However, when a finger is touching one or more other sections of the fingerprint sensor 112, for such other sections the sensor 112 provides an indication to the auxiliary functionality module 120 of the sections of the sensor structure 110 that are sensed by the sensor 112 as being



touched by the finger. The indication can be an identification of where in the section the sensor is being touched, such as one or more coordinates (e.g., using a Cartesian coordinate system) on the sensor **112** that are touched, an indication that either the section is being touched or not being touched, and so forth.

Thus, each of the sensors **112** and **114** provides an indication to the fingerprint identification module **118** and/or the auxiliary functionality module **120** when the sensor is being touched, as well as possibly an indication of where the sensor is being touched or the fingerprint data sensed. As long as the sensor is being touched, the sensor provides these indications at regular or irregular intervals to the module **118** and/or the module **120**. When a sensor is no longer being touched, the sensor ceases providing these indications to the module **118** and/or the module **120**.

A user input from a user of the system **600** is received in the form of the user's finger moving across the surface of the sensor structure **110**. As the user's finger moves across the sensor structure **110**, indications of which of the sensors **112** and/or **114** are being touched, and optionally an indication of where the sensors **112** and/or **114** are being touched, are input to the auxiliary functionality module **120**. The module **120** determines a pattern of movement of the user's finger, such as a direction of the movement, a shape of the movement, a speed or velocity of the movement, and so forth. The module **120** also determines an operation associated with the determined pattern of movement of the user's finger, and performs the associated operation in response to the user input.

The pattern of movement of the user's finger can be readily determined by the module **120** based on the indications of which of, and optionally the indications of where, the sensors **112** and/or **114** are being touched and the order of the touching (e.g., as identified by the order in which the indications of touches are received from the sensor structure **110** or other timing information associated with the indications of the touches). Alternatively, rather than the module **120** determining the pattern of movement of the user's finger, the pattern can be determined by another module or control system and provided to the module **120**.

Additionally, indications of fingerprint data sensed by the fingerprint sensor **112** as the user's finger moves across the fingerprint sensor **112** are provided to the fingerprint identification module **118**. The fingerprint data identifies a pattern of a user's fingerprint that was sensed or detected by the fingerprint sensor **112**. The fingerprint identification module **118** uses the sensed fingerprint data to attempt to authenticate the user's fingerprint as discussed in more detail below.

The sensor structure **110** can be implemented using different types of fingerprint sensors, including touch fingerprint sensors and swipe fingerprint sensors. A touch fingerprint sensor refers to a fingerprint sensor that can sense main fingerprint characteristics used to authenticate the user's fingerprint at approximately the same time. Thus, the touch fingerprint sensor does not rely on, but allows, movement of the user's finger while sensing the fingerprint data. A swipe fingerprint sensor, on the other hand, senses the fingerprint data used to authenticate the user's fingerprint over time as a user swipes his or her finger across the fingerprint sensor. The fingerprint data sensed at different times by the swipe fingerprint sensor is combined (also referred to as stitched together) to generate main fingerprint characteristics. This combining can be performed by various components, such as the fingerprint sensor **112** or the fingerprint identification module **118**, and can be performed using any of a variety of public and/or proprietary techniques. Thus, the swipe fingerprint sensor can have a surface size smaller than the fingerprint of the user

because substantially all of the fingerprint data for the multiple fingers need not be sensed at approximately the same time.

FIGS. **7**, **8**, and **9** illustrate top-down views of an example sensor structure **110** including touch fingerprint sensors in accordance with one or more embodiments. In the illustrated example of FIG. **7**, the fingerprint sensor **112** is a touch fingerprint sensor implemented in a grid-type arrangement. The touch sensors **114** each include multiple (3 are illustrated) segments. These multiple segments can be implemented in different manners, such as each of the segments being a discrete sensor, or each sensor **114** being implemented in a grid-type arrangement.

Different sections of the fingerprint sensor **112** are assigned different functions. Some sections of the fingerprint sensor **112** are assigned the function of fingerprint data sensing, and these sections sense fingerprint data as the user's finger is moved across the fingerprint sensor **112**. This sensed fingerprint data is then provided to a fingerprint identification module to attempt to authenticate the fingerprint. Sections of the fingerprint sensor **112** assigned the function of fingerprint data sensing can also sense fingerprint data without the user's finger moving across the sensor **112** (e.g., when the user's finger touches the fingerprint sensor **112** and remains stationary).

Other sections of the fingerprint sensor **112** are assigned the function of movement sensing, and these sections sense the movement of the user's finger across the fingerprint sensor **112**. Indications of the sections that are sensed as touched by the user's finger as it is moved across the fingerprint sensor **112** are provided to an auxiliary functionality module to perform the appropriate operation based on the user input.

Each of the different sections of the fingerprint sensor **112** can be assigned the function of fingerprint data sensing or movement sensing in different manners. In one embodiment, the function of each section of the sensor **112** is predetermined (e.g., by a designer of the sensor structure **110** or system **600**). In another embodiment, a control module or system assigns the function of each section of the sensor dynamically, allowing the assignments of functions to sections to change over time. The control module or system routes the sensed fingerprint data from sections assigned fingerprint data sensing to the fingerprint identification module, and routes indications of the sections that are sensed by the sensor **112** as being touched by the finger from sections assigned movement sensing to the auxiliary functionality module.

The assignments of functions to sections can change for various reasons, and can be based on a current state of the device implementing system **600**, on contextual circumstances of receipt of the user input (e.g., such as applications to be accessed by the user input), or various other bases. For example, the assignments of function to sections can change, such as increasing the number of sections sensing fingerprint data in response to fingerprint authentication failing at at least a threshold rate, increasing the number of sections sensing movement in response to finer sensing granularity being desired by the auxiliary functionality module **120**, decreasing the number of sections sensing movement in response to coarser sensing granularity being desired by the auxiliary functionality module **120**, increasing or decreasing the number of sections sensing movement based on a number of sections an auxiliary functionality module **120** desires to be assigned to sensing movement, and so forth.

Various different sections of the fingerprint sensor **112** can be assigned the function of movement sensing. FIG. **8** illustrates the sensor structure **110** of FIG. **7** with the fingerprint



sensor **112** including two sections **802** and **804** being assigned the function of movement sensing and one section **806** being assigned the function of fingerprint data sensing. In the illustrated example of FIG. **8**, approximately the top third of the fingerprint sensor **112** and approximately the bottom third of the fingerprint sensor **112** is assigned the function of movement sensing, and approximately the middle third of the fingerprint sensor **112** is assigned the function of fingerprint data sensing.

The movement of the user's finger across the sensor structure **110** is illustrated using arrows **810**, **812**, and **814**. For example, a particular operation of the auxiliary functionality module may be requested by a user moving his or her finger in a pattern that is vertical across the sensor structure **110**, illustrated as arrow **810**. The auxiliary functionality module can optionally allow some variance in this pattern of movement, so that if the user moves his or her finger in a pattern approximately vertically across the sensor structure **110**, illustrated as arrow **812** or **814**, the auxiliary functionality module determines that the user input is requesting that particular operation associated with the vertical movement pattern across the sensor structure **110**. Further, while straight lines are shown, the movement can be wavy, zig-zag, round, or any other pattern, as far as the movement is following substantially an up-down direction. Additionally, while the arrows are shown through the center of the sensor structure **110**, the motion may be anywhere across the sensor width.

Additionally, as can be seen in FIG. **8**, as the user provides a user input by moving his or her finger across the sensor structure **110** in a pattern of an arrow **810**, **812**, or **814**, both the touch sensors **114** and the fingerprint sensor **112** are touched as part of the same user input. Additionally, both the sections of the fingerprint sensor **112** assigned the function of movement sensing and the sections of the fingerprint sensor **112** assigned the function of fingerprint data sensing are touched as part of the same user input.

It should be noted that although the arrows **810**, **812**, and **814** indicate that both touch sensors **114** are touched, both touch sensors **114** need not be touched. For example, a user input can begin or end in fingerprint sensor **112**.

FIG. **9** illustrates the sensor structure **110** of FIG. **7** with the fingerprint sensor **112** including multiple sections **902** being assigned the function of movement sensing and multiple sections **904** being assigned the function of fingerprint data sensing. The sensor structure **110** of FIG. **9** is analogous to the sensor structure **110** of FIG. **8**, except for the number and size of the sections assigned the function of movement sensing and the number and size of the sections assigned the function of fingerprint data sensing. As illustrated, the sections **902** assigned the function of movement sensing are more numerous but each smaller in size than the sections **802** assigned the function of movement sensing in the sensor structure **110** of FIG. **8**. Similarly, the sections **904** assigned the function of fingerprint data sensing are more numerous but each smaller in size than the sections **806** assigned the function of fingerprint data sensing in the sensor structure **110** of FIG. **8**.

Thus, as can be seen in FIGS. **7-9**, different sections of the touch fingerprint sensor **112** provide different functionality. Some sections sense fingerprint data as the user moves his or her finger over the fingerprint sensor **112**, and other sections sense the movement of the user's finger over the fingerprint sensor **112**. Which sections are assigned which functions, the size of the sections, and the number of the sections can vary.

It should be noted that although in the examples of FIGS. **8** and **9**, the sections are approximately rectangular in shape and span the width of the fingerprint sensor **112**, the sections can be of any size and any shape. For example, the sections can be

circular, triangular, or any other shape. By way of another example, the sections can span the height of the fingerprint sensor **112**, or span neither the width nor height of the sensor **112**.

It should also be noted that because some sections of the fingerprint sensor **112** are not used to sense fingerprint data, the fingerprint data obtained from the one or more sections of the fingerprint sensor **112** that do sense fingerprint data may not sense fingerprint data for the entire fingerprint at one time. Additionally, because the user's finger is moving across the sensor structure **110**, there is typically not a duration of time where the user's finger is stationary for the fingerprint sensor **112** to sense the fingerprint data. Accordingly, the sensed fingerprint data can be handled in different manners.

In one embodiment, the one or more sections of the touch fingerprint sensor **112** that sense fingerprint data operate as a swipe fingerprint sensor. Thus, in this embodiment the fingerprint data sensed by the one or more sections of the fingerprint sensor **112** that sense fingerprint data as the user's finger moves over those one or more sections is combined to generate main fingerprint characteristics for the finger.

In another embodiment, the fingerprint identification module **118** relies on fingerprint data for only a portion of the fingerprint (the portion captured by the one or more sections of the touch fingerprint sensor **112** that sense fingerprint data at one time). The fingerprint template used for authentication can similarly include only that portion of the fingerprint, or only that portion of the fingerprint template may be used for authentication. Additionally, because the user's finger is moving across the sensor structure **110**, in this embodiment a determination can be made as to when to sense the fingerprint data. The determination can be made, for example, to sense the fingerprint data at a time when all of the sections of the sensor **112** that sense fingerprint data sense the finger touching the sensor **112**. Alternatively, the fingerprint data may be sensed at multiple times as the user moves his or her finger across the sensor **112**, resulting in multiple sets of fingerprint data being sensed, and one of the sets of fingerprint data may be selected as the sensed fingerprint data to compare to the fingerprint template for authentication. The selected set of fingerprint data can be, for example, the set of data indicating the largest number (or any set including at least a threshold number) of ridges and/or minutiae.

FIGS. **10** and **11** illustrate top-down views of an example sensor structure **110** including swipe fingerprint sensors in accordance with one or more embodiments. In the illustrated example of FIG. **10**, the fingerprint sensor **112** is a swipe fingerprint sensor implemented in a grid-type arrangement. The touch sensors **114** each include multiple (3 are illustrated) segments. These multiple segments can be implemented in different manners, such as each of the segments being a discrete sensor, or each sensor **114** being implemented in a grid-type arrangement.

In one embodiment, given the similar size of the swipe fingerprint sensor relative to a touch sensor **114** segment, different sections of the swipe fingerprint sensor **112** are not assigned different functions. Rather, as the user moves his or her finger across the sensor structure **110**, movement of the user's finger is detected based on touch as sensed by the touch sensors **114**, and the fingerprint data is sensed by the fingerprint sensor **112**.

In another embodiment, different sections of the swipe fingerprint sensor **112** are assigned different functions. Some sections are assigned the function of fingerprint data sensing and other sections are assigned the function of movement sensing. Which sections are assigned which functions, the



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size of the sections, and the number of the sections can vary analogous to the discussion above regarding the fingerprint sensor **112** of FIGS. **8** and **9**.

In the illustrated example of FIG. **11**, the fingerprint sensor **112** is a swipe fingerprint sensor and the touch sensors **114** each include multiple segments. The sensor structure **110** of FIG. **11** is the sensor structure **110** of FIG. **10**, but with the movement of the user's finger across the sensor structure **110** illustrated using arrows **810**, **812**, and **814**. Analogous to the discussion above regarding FIG. **8**, user input in the pattern of the arrows **810**, **812**, or **814** can be input by a user to request a particular operation of the auxiliary functionality module be performed. Also analogous to the discussion above regarding FIG. **8**, it should be noted that although the arrows **810**, **812**, and **814** indicate that both touch sensors **114** are touched, both touch sensors **114** need not be touched. For example, a user input can begin or end in fingerprint sensor **112**.

FIG. **12** illustrates an example process **1200** implementing the auxiliary functionality control and fingerprint authentication based on a same user input in accordance with one or more embodiments. Process **1200** is implemented by one or more devices or structures, such as by the device **102** of FIG. **1**, by the device **302** and the sensor structure **110** of FIG. **3**, and so forth. Process **1200** can be implemented in software, firmware, hardware, or combinations thereof. Process **1200** is shown as a set of acts and is not limited to the order shown for performing the operations of the various acts. Process **1200** is an example of implementing the auxiliary functionality control and fingerprint authentication based on a same user input discussed herein; additional discussions of implementing the auxiliary functionality control and fingerprint authentication based on a same user input are included herein with reference to different FIGs.

In process **1200**, a user input is received in the form of a finger moving across a sensor structure that includes both a fingerprint sensor and a touch sensor (act **1202**). The finger is moved across both the fingerprint sensor and the touch sensor, as discussed above.

Indications of sensors of the sensor structure being touched, and optionally indications of where the sensors are touched, are provided to the auxiliary functionality module (act **1204**) as the user's finger is moved across the sensor structure. Additionally, sensed fingerprint data is provided to the fingerprint identification module (act **1206**) as the user's finger is moved across the sensor structure.

Process **1200** proceeds with different acts being performed by the auxiliary functionality module and the fingerprint identification module based on the same user movement of the user's finger across the sensor structure.

The auxiliary functionality module determines a pattern of movement of the user's finger (act **1208**). Various different patterns of movement can be input, and the pattern of movement of the user's finger can be readily determined by the module **120** based on which, and optionally where, the sensors **112** and/or **114** are touched and the order in which those touches occur. These patterns can include the user's finger moving across the sensor structure **110** in a line, circle, or any other shape or path.

An operation of the auxiliary functionality associated with the pattern of movement is identified (act **1210**). The operations associated with particular patterns can vary by implementation, and can be enabled by sensor design and capability. The patterns can also optionally be user-configurable, allowing a user to choose from one of a set of multiple patterns or allowing the user to customize the pattern to be any pattern he or she desires.

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The identified operation is performed (act **1212**). Thus, the auxiliary functionality is controlled by the pattern of movement of the user's finger across the sensor structure. Various different operations can be performed based on the particular auxiliary functionality module. It should be noted that although some of the discussions herein refer to an operation associated with a pattern of movement being identified and performed, alternatively multiple operations associated with a pattern of movement can be identified and performed (e.g., concurrently, sequentially, etc.).

It should be noted that optionally the pattern of movement can be determined and the identified operation performed while the user input is being received. For example, if the auxiliary functionality is cursor control and the module moves a cursor or pointer on a display in the same pattern as the movement of the user's finger, then the pattern of movement is identified and the operation (cursor or pointer movement) is performed as the user input is being received. Alternatively, the pattern of movement may be determined and the identified operation performed after the user input has ended.

Generally, the auxiliary functionality refers to any functionality that can be controlled by user inputs to the sensor structure **110**. Although specific examples of auxiliary functionality are discussed herein, it should be noted that the techniques discussed herein are not limited to these specific examples.

In one embodiment, the auxiliary functionality is volume control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** increases or decreases volume based on the user input to the sensor structure **110**. For example, in response to movement of the user's finger across the sensor structure **110** in one direction the module **120** increases the volume of audio output by the device, and in response to movement of the user's finger across the sensor structure **110** in another direction the module **120** decreases the volume of audio output by the device.

In another embodiment, the auxiliary functionality is game control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** performs various operations in a game based on the user input to the sensor structure **110**. The particular operation performed can vary based on the game implementation. For example, in response to movement of the user's finger across the sensor structure **110** in a particular direction the module **120** may move a character or object in the game in that particular direction.

In another embodiment, the auxiliary functionality is cursor control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** moves a cursor or pointer on a display of the device based on the user input to the sensor structure **110**. For example, in response to movement of the user's finger across the sensor structure **110** in a particular direction the module **120** moves a cursor or pointer on the display of the device in the same direction as the movement of the user's finger.

In another embodiment, the auxiliary functionality is zoom control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** zooms in or out on the content displayed on a display of the device based on the user input to the sensor structure **110**. For example, in response to movement of the user's finger across the sensor structure **110** in one direction the module **120** zooms in on the content being displayed, and in response to movement of the user's finger across the sensor structure **110** in another direction the module **120** zooms out on the content being displayed by the device.



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In another embodiment, the auxiliary functionality is scroll control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** scrolls through content displayed on a display of the device based on the user input to the sensor structure **110**. For example, in response to movement of the user's finger across the sensor structure **110** in one direction the module **120** scrolls the content being displayed in one direction (e.g., up or to the left), and in response to movement of the user's finger across the sensor structure **110** in another direction the module **120** scrolls the content being displayed in another direction (e.g., down or to the right).

In another embodiment, the auxiliary functionality is menu control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** switches through menus and/or items in a menu displayed on a display of the device based on the user input to the sensor structure **110**. For example, in response to movement of the user's finger across the sensor structure **110** in one direction the module **120** switches to another menu (e.g., the next menu to the left of a currently displayed menu) or another menu item (e.g., the next menu item above the currently highlighted menu item), and in response to movement of the user's finger across the sensor structure **110** in another direction the module **120** switches to another menu (e.g., the next menu to the right of a currently displayed menu) or another menu item (e.g., the next menu item below the currently highlighted menu item).

In another embodiment, the auxiliary functionality is photography control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** performs various operations related to image capture based on the user input to the sensor structure **110**. The particular operation performed can vary based on implementation. For example, in response to movement of the user's finger across the sensor structure **110** in a particular direction the module **120** may take a picture (capture an image), zoom in or zoom out on the scene being captured, increase or decrease exposure time, and so forth.

In another embodiment, the auxiliary functionality is phone call control for a device (e.g., the device implementing the auxiliary functionality module **120**). The auxiliary functionality module **120** performs various operations related to controlling phone calls based on the user input to the sensor structure **110**. The particular operation performed can vary based on implementation. For example, in response to movement of the user's finger across the sensor structure **110** in a particular direction the module **120** may answer a ringing telephone, hang up on a current call, and so forth.

Although various embodiments providing different auxiliary functionality are discussed, it should be noted that multiple ones of these embodiments can be combined. System **600** of FIG. **6** can optionally include multiple auxiliary functionality modules **120**, and a particular one of those multiple auxiliary functionality modules **120** can be enabled based on a current state of the device implementing system **600**, and also on contextual circumstances of receipt of the user input. The state of the device or contextual circumstances refers to one or more of a manner in which the device is currently being used, a current power state of the device, which programs are currently running on the device, which programs or functionality are available on the device, device motion, speed, where the device is located, time of day, and so forth. For example, if a game is currently being played then an auxiliary functionality module **120** that provides game control for the device can be enabled, if the device includes phone functionality and the device is currently ringing (indicating an incoming phone

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call) then an auxiliary functionality module **120** that provides phone call control for the device can be enabled.

It should also be noted that auxiliary functionality of multiple auxiliary functionality modules **120** can be implemented concurrently, and the pattern of movement of the user's finger used to determine which of the modules **120** is to perform an operation based on the user input. For example, in response to a movement of the user's finger across the sensor structure in one dimension (e.g., horizontally, or along an x axis in a Cartesian coordinate system) an auxiliary functionality module **120** can be enabled (or can be configured to respond to movement in that dimension) to provide volume control for the device implementing system **600**, and in response to a movement of the user's finger across the sensor structure in a different dimension (e.g., vertically, or along a y axis in a Cartesian coordinate system) an auxiliary functionality module **120** can be enabled (or can be configured to respond to movement in that dimension) that provides menu control for the device. An example of a 2-dimensional Cartesian coordinate system is illustrated in FIG. **2**, with a y axis **202** and an x axis **204**.

In process **1200**, based on the same user input as is used to determine the pattern of movement of the user's finger, an attempt to authenticate the fingerprint in the sensed fingerprint data is made (act **1214**). The attempt to authenticate the fingerprint is made based on the fingerprint data sensed while the finger is moving across the sensor structure.

Process **1200** proceeds based on whether the attempt is successful (act **1216**). If the attempt is successful, then the fingerprint (and the user) is authenticated (act **1218**). However, if the attempt is unsuccessful, then the fingerprint (and the user) is not authenticated (act **1220**).

Various different actions can be taken based on whether the fingerprint is authenticated or not authenticated. For example, the control system of the device may allow continued operation of the device only if at least a threshold number of the attempts are successful. If at least a threshold number of attempts are not successful, the control system may provide a warning to the user that he or she is not authorized, may require a separate user authentication process (other than the authentication performed as the user moves his or her finger across the sensor structure), and so forth.

The fingerprint data sensed in act **1206** identifies a pattern of a user's fingerprint that was sensed or detected by the fingerprint sensor **112** as discussed above. In one embodiment, this fingerprint data is an indication of the locations where minutiae and/or ridges of the fingerprint are sensed or identified by the fingerprint sensor **112**. The locations can be identified in various different manners, such as using a 2-dimensional Cartesian coordinate system in which the locations where minutiae or ridges are sensed are identified using x,y coordinates. Alternatively, other coordinate systems can be used, such as Polar coordinate systems, proprietary coordinate systems, and so forth.

The fingerprint identification module **118** analyzes the sensed fingerprint data and compares it to the fingerprint template for the user. The fingerprint template can be stored in the same device as implements the fingerprint identification module **118**, or alternatively can be stored in a separate device (e.g., accessible to the fingerprint identification module **118** via any of a variety of data networks). The fingerprint template for the user's finger can be stored at various times, such as during an enrollment process, which refers to a process during which the user is setting up or initializing the fingerprint identification module **118** to authenticate his or her fingerprint.



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The fingerprint identification module **118** compares the sensed fingerprint to the fingerprint template, and based on this comparison the fingerprint identification module **118** determines whether the sensed fingerprint satisfies the fingerprint template. When the fingerprint satisfies the fingerprint template (e.g., the fingerprint data matches the fingerprint template), the fingerprint authentication succeeds and the fingerprint (and the user) is authenticated. When the fingerprint does not satisfy the fingerprint template (e.g., the fingerprint data does not match the fingerprint template), the fingerprint authentication fails and the fingerprint (and the user) is not authenticated. The fingerprint identification module **118** can make this comparison in different manners in accordance with various different embodiments. In one embodiment, the fingerprint identification module **118** compares the sensed fingerprint data to the fingerprint template and determines whether the sensed fingerprint data matches the fingerprint template for the user.

The fingerprint identification module **118** can determine whether the sensed fingerprint data and the fingerprint template match in various different manners. In one embodiment, the locations where minutiae or ridges are detected as indicated in the sensed fingerprint data and the fingerprint template are compared. If the number of corresponding locations in the sensed fingerprint data and the fingerprint template where minutiae or ridges are detected satisfies (e.g., is equal to and/or greater than) a threshold value, the sensed fingerprint data and the fingerprint template match; otherwise, the sensed fingerprint data and the fingerprint template do not match. Various different correlation or alignment techniques can be used to align the two fingerprint data so that corresponding features (e.g., at the same coordinates relative to an origin or other reference point) can be readily identified. Alternatively, various other public and/or proprietary pattern matching techniques can be used to determine whether the sensed fingerprint data and the fingerprint template match.

Thus, as can be seen from the discussions herein, both fingerprint authentication and auxiliary functionality control are based on the same user input. A single user input of the user moving his or her finger across the sensor structure results in the operation associated with the pattern of movement as determined by an auxiliary functionality module being performed, as well as the user's fingerprint being authenticated. Therefore, the user's fingerprint is authenticated automatically while the user is providing user input to control auxiliary functionality of the device.

Various different examples of implementing the sensor structure **110** are discussed with reference to FIGS. **13**, **14**, **15**, **16**, and **17**. The examples of FIGS. **13-17** are top-down views of example sensor structures **110**. It should be noted that the examples of FIGS. **13-17** are only examples, and that the sensor structure **110** can be implemented using various other configurations of fingerprint and touch sensors.

FIGS. **13**, **14**, **15**, **16**, and **17** each illustrate a different example sensor structure **110** that includes the fingerprint sensor **112** surrounded by touch sensors **114**. These different example sensor structures illustrate different shapes and/or arrangements of sensors in a sensor structure **110**. The touch sensors **114** of the different sensor structures **110** may be implemented as single sensors or in a grid-type arrangement as discussed above. The fingerprint sensors **112** of the different sensor structures **110** can be touch fingerprint sensors or swipe fingerprint sensors as discussed above.

FIG. **18** illustrates various components of an example electronic device **1800** that can be implemented as a device as described with reference to any of the previous FIGS. **1-17**. The device **1800** may be implemented as any one or combi-

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nation of a fixed or mobile device, in any form of a consumer, computer, portable, wearable, user, communication, phone, navigation, gaming, messaging, Web browsing, paging, media playback, and/or other type of electronic device.

The electronic device **1800** can include one or more data input ports **1802** via which any type of data, media content, and/or inputs can be received, such as user-selectable inputs, messages, music, television content, recorded video content, and any other type of audio, video, and/or image data received from any content and/or data source. The data input ports **1802** may include USB ports, coaxial cable ports, and other serial or parallel connectors (including internal connectors) for flash memory, DVDs, CDs, and the like. These data input ports may be used to couple the electronic device to components, peripherals, or accessories such as keyboards, microphones, or cameras.

The electronic device **1800** of this example includes a processor system **1804** (e.g., any of microprocessors, controllers, and the like), or a processor and memory system (e.g., implemented in an SoC), which process computer-executable instructions to control operation of the device. A processing system may be implemented at least partially in hardware, which can include components of an integrated circuit or on-chip system, an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), a complex programmable logic device (CPLD), and other implementations in silicon and/or other hardware. Alternatively or in addition, the electronic device can be implemented with any one or combination of software, hardware, firmware, or fixed logic circuitry that is implemented in connection with processing and control circuits, which are generally identified at **1806**. Although not shown, the electronic device can include a system bus or data transfer system that couples the various components within the device. A system bus can include any one or combination of different bus structures, such as a memory bus or memory controller, a peripheral bus, a universal serial bus, and/or a processor or local bus that utilizes any of a variety of bus architectures.

The electronic device **1800** also includes one or more memory devices **1808** that enable data storage, examples of which include random access memory (RAM), non-volatile memory (e.g., read-only memory (ROM), flash memory, EPROM, EEPROM, etc.), and a disk storage device. A memory device **1808** provides data storage mechanisms to store the device data **1810**, other types of information and/or data, and various device applications **1812** (e.g., software applications). For example, an operating system **1814** can be maintained as software instructions with a memory device and executed by the processor system **1804**.

In embodiments, the electronic device **1800** includes a fingerprint identification module **118** and an auxiliary functionality module **120** as described above. Although represented as a software implementation, each of the fingerprint identification module **118** and the auxiliary functionality module **120** may be implemented as any form of a control application, software application, signal-processing and control module, firmware that is installed on the device, a hardware implementation, and so on. The electronic device **1800** can also include a sensor structure **110** as described above.

The electronic device **1800** can also include an audio and/or video processing system **1820** that processes audio data and/or passes through the audio and video data to an audio system **1822** and/or to a display system **1824**. The audio system and/or the display system may include any devices that process, display, and/or otherwise render audio, video, display, and/or image data. Display data and audio signals can be communicated to an audio component and/or to a display



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component via an RF (radio frequency) link, S-video link, HDMI (high-definition multimedia interface), composite video link, component video link, DVI (digital video interface), analog audio connection, or other similar communication link, such as media data port 1826. In implementations, the audio system and/or the display system are external components to the electronic device. Alternatively or in addition, the display system can be an integrated component of the example electronic device, such as part of an integrated touch interface.

Although embodiments of auxiliary functionality control and fingerprint authentication based on a same user input have been described in language specific to features and/or methods, the subject of the appended claims is not necessarily limited to the specific features or methods described. Rather, the specific features and methods are disclosed as example implementations of auxiliary functionality control and fingerprint authentication based on a same user input.

The invention claimed is:

**1.** A method comprising:

receiving a user input of a finger moving across a sensor structure of a mobile device, the sensor structure including a fingerprint sensor, a first touch sensor adjacent to the fingerprint sensor and a second touch sensor adjacent to the fingerprint sensor, the fingerprint sensor situated between the first touch sensor and the second touch sensor, the fingerprint sensor comprising multiple sections;

assigning one or more of the multiple sections to one of sensing fingerprint data and sensing movement of the finger across the fingerprint sensor;

performing auxiliary functionality of a device based on a pattern of movement of the finger across the sensor structure and sections of the fingerprint sensor assigned to sensing movement; and

authenticating a fingerprint of the finger based on fingerprint data sensed by sections of the fingerprint sensor assigned to sensing fingerprint data during the finger moving across the sensor structure.

**2.** The method as recited in claim 1, further comprising determining the pattern of movement of the finger across the sensor structure based on the finger touching both the touch sensor and the fingerprint sensor while moving across the sensor structure.

**3.** The method as recited in claim 1, the method further comprising receiving an indication of the fingerprint data from one of the multiple sections of the fingerprint sensor, and receiving from another of the multiple sections of the fingerprint sensor an indication of the section of the fingerprint sensor touched while the finger is moving across the fingerprint sensor.

**4.** The method as recited in claim 1, the dynamically assigning further comprising dynamically assigning one or more of the multiple sections in response to contextual circumstances of receipt of the user input.

**5.** The method as recited in claim 1, the performing auxiliary functionality of the device comprising enabling one of multiple auxiliary functionality modules of the device in response to different patterns of movement, different ones of the multiple auxiliary functionality modules performing different operations for different auxiliary functionality.

**6.** The method as recited in claim 1, the performing auxiliary functionality of the device comprising enabling one of multiple auxiliary functionality modules of the device in response to contextual circumstances of receipt of the user input.

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**7.** The method as recited in claim 1, wherein the auxiliary functionality of the device comprises a volume control of the device in which the user input is used as volume control input.

**8.** The method as recited in claim 1, wherein the auxiliary functionality of the device comprises game control, cursor control, zoom control, scroll control, menu control, photography control, or phone call control.

**9.** The method of claim 1, wherein assigning the one or more of the multiple sections further comprises dynamically assigning the one or more of the multiple sections based on a current state of the mobile device or a contextual circumstance of receipt of the user input.

**10.** A mobile device comprising:

one or more processors;

a machine-readable medium comprising instructions stored therein, which when executed by the one or more processors, cause the processors to perform operations comprising:

assigning one or more of multiple sections of a fingerprint sensor to one of sensing fingerprint data and sensing movement of a finger across the fingerprint sensor;

performing one or more auxiliary functionality operations based on a user input of the finger moving across a sensor structure and sections of the fingerprint sensor assigned to sensing movement, the sensor structure including a first touch sensor adjacent to the fingerprint sensor and a second touch sensor adjacent to the fingerprint sensor, the fingerprint sensor situated between the first sensor and the second sensor; and

attempting to authenticate a fingerprint of the finger based on fingerprint data sensed by sections of the fingerprint sensor assigned to sensing fingerprint data during the same user input upon which performance of the one or more auxiliary functionality operations is based.

**11.** The device as recited in claim 10, the device including the sensor structure.

**12.** The device as recited in claim 10, the one of the multiple sections sensing fingerprint data operating as a swipe fingerprint sensor that senses the fingerprint data as the finger is swiped across the one section.

**13.** The device as recited in claim 10, the fingerprint sensor comprising a swipe fingerprint sensor that senses the fingerprint data as the finger is swiped across the fingerprint sensor.

**14.** The device as recited in claim 10, wherein the operations further comprises performing one or more additional auxiliary functionality operations based on the user input, the user input comprising a pattern of movement of the finger moving across the sensor structure, and performing an auxiliary functionality operation based on the pattern of movement.

**15.** The device as recited in claim 10, further comprising operations for volume control, game control, cursor control, zoom control, scroll control, menu control, photography control, or phone call control.

**16.** The device as recited in claim 10, the device comprising a wireless phone.

**17.** The device of claim 10, wherein assigning the one or more of the multiple sections further comprises dynamically assigning the one or more of the multiple sections based on a current state of the mobile device or a contextual circumstance of receipt of the user input.

**18.** A system comprising:

a sensor structure configured to sense a finger moving across the sensor structure, the sensor structure including a plurality of touch sensors surrounding a fingerprint sensor, the fingerprint sensor comprising multiple sections;

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one or more processors;  
 a machine-readable medium comprising instructions stored therein, which when executed by the one or more processors, cause the processors to perform operations comprising:  
 5 assigning one or more of the multiple sections to one of sensing fingerprint data and sensing movement of the finger across the fingerprint sensor;  
 controlling auxiliary functionality of the system based on a pattern of movement of the finger across the sensor structure and sections of the fingerprint sensor assigned to sensing movement; and  
 attempting to authenticate a fingerprint of the finger based on fingerprint data sensed by sections of the fingerprint sensor assigned to sensing fingerprint data while the finger moves across the sensor structure.  
 19. The system as recited in claim 18, wherein the one or more sections of the fingerprint sensor that are assigned the function of fingerprint data sensing operate as a swipe finger-

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print sensor that sense the fingerprint data as the finger is swiped across the one or more sections.

20. The system as recited in claim 18, the fingerprint sensor comprising a swipe fingerprint sensor that senses the fingerprint data as the finger is swiped across the fingerprint sensor.  
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21. The system as recited in claim 18, wherein the operations further comprises operations for volume control, game control, cursor control, zoom control, scroll control, menu control, photography control, or phone call control.

10 22. The system as recited in claim 18, wherein the operations further comprises operations to control additional auxiliary functionality of the system based on the pattern of movement of the finger across the sensor structure.

15 23. The system of claim 18, wherein assigning the one or more of the multiple sections further comprises dynamically assigning the one or more of the multiple sections based on a current state of the mobile device or a contextual circumstance of receipt of the pattern of movement of the finger.

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